Users guide and and maintenance manual

Mitsubishi

SL series

Version 08/2004

33522049401_2_1

INTRODUCTION

This publication covers the standard specification model for the Mitsubishi SL-Series diesel engines. The information, specifications, and illustrations in this publication are based on the information that was current at the time this issue was written.

This manual contains operation instructions, lubrication and maintenance information.

The OPERATION section is a reference for the new operator and a refresher for the experienced operator. Read — study — and keep it handy. Illustrations guide the operator through correct procedures of checking, starting, operating, and stopping the engine. Operating techniques outlined in this manual are basic. Skills and techniques develop as the operator gains knowledge of the engine.

The MAINTENANCE section is a guide to engine care. The illustrated, step-by-step instructions are grouped by service intervals. Items without specific intervals are listed under "When Required." Items in the Lubrication and Maintenance Chart are referred to in the detailed instructions which follow.

Notice that the technical information in this manual depends on the specification of the engine and the accessories. All specifications are subject to change without any prior notice.

For items other than those in this publication, please refer to the operation manual of the equipment in which this engine is installed.

Operation Manual
Mitsubishi SL-Series diesel engines
Version 08/2004
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WARNING SIGNS

The following safety related signs are used in this manual to emphasize important and critical instructions:

⚠ DANGER — Indicates the most serious specific potential hazard which could result in serious personal injury or death.

⚠ WARNING — Indicates a specific potential hazard which could result in personal injury.

⚠ CAUTION — Indicates operating procedures, practices, etc. which could result in personal injury or damage causing destruction to the engine. Some of the CAUTION signs also indicate a specific potential hazard which could result in serious personal injury or death.

⚠ NOTE — Indicates procedures, conditions, etc. which are important to highlight.

Symbols

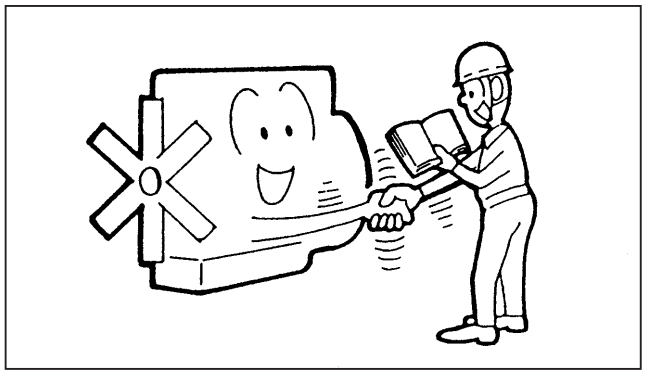
✓ Indicates a proper action or "DO".

⊘ Indicates a prohibited action or "DON'T".

Recommendation of daily operation records

It is obvious to every engine user and operator that an engine should not be run to destruction. Daily recording is a preventive maintenance program and will serve as a guide for:

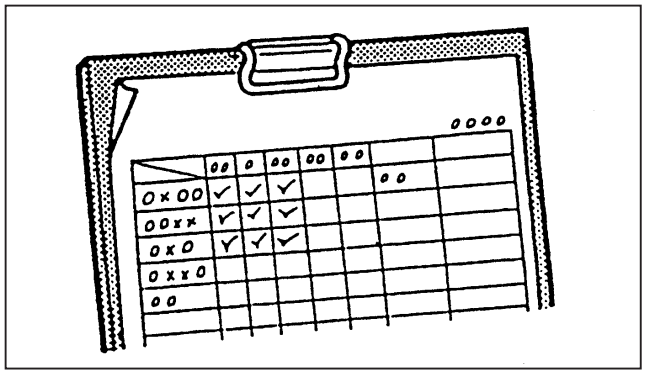
- Effective troubleshooting (to help a serviceman from your Mitsubishi dealer to pin-point a problem).
- Quick service and less downtime (to help a serviceman from your Mitsubishi dealer save time (and costs for service))
- Grasp of operating conditions (to help you recognize conditions, signs or indications of approaching trouble)



Items to be recorded

The following items are recommended to be recorded:

1. Operating hours (service hour meter reading)
2. The amount of oil, fuel, and coolant (soft water) required for refilling
3. Oil and coolant change intervals
4. Engine oil pressure, exhaust temperature, coolant temperature, and inlet air temperature
5. Parts serviced, kinds of service (adjustment, repairs or replacement), and the results of each service
6. Changes in operating conditions (for example, "Exhaust smoke turned black," etc.)



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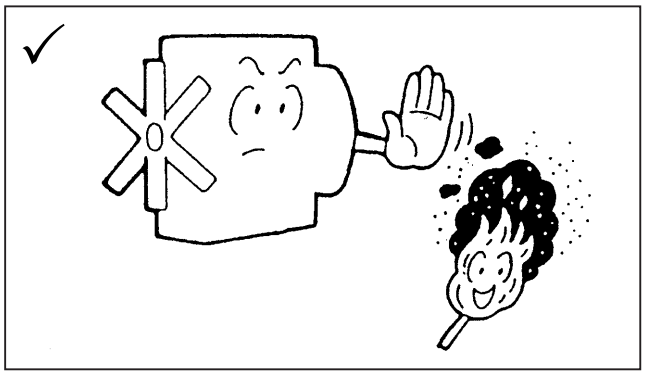
1 SAFETY

1.1 Preventing fire and explosions

⚠ **Fire hazards!**

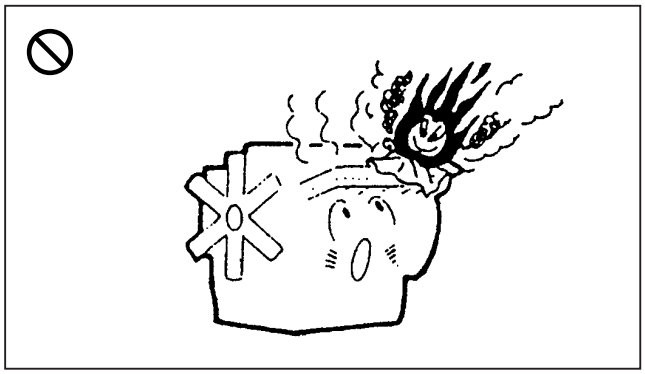


Do not smoke while refueling, or when handling fuel containers. Do not use gasoline or diesel fuel for cleaning parts. Good quality commercial, non-flammable, and non-toxic solvents are recommended. Do not spill any fuel on hot surfaces. Clean up any spillage immediately.

⚠ **Do not fill fuel tank while the engine is running!**

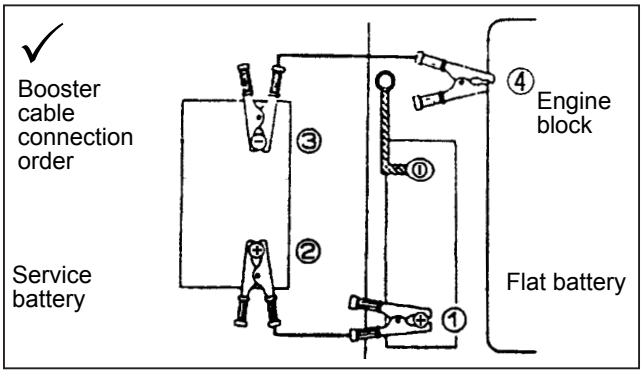
Shut off the engine when fueling and use extra caution if the engine is hot.

⚠ **Do not bring close to flammable materials!**



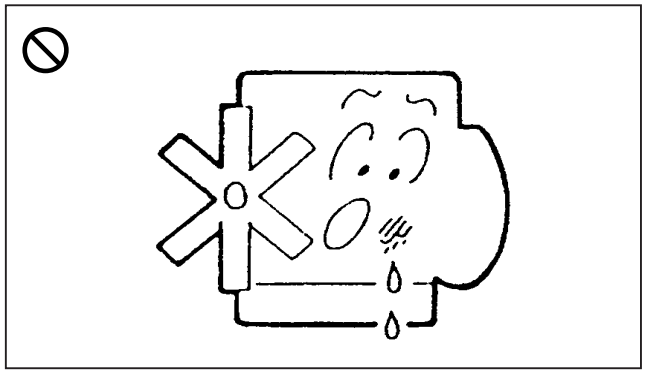
Do not put flammable materials on hot parts of the exhaust pipe. Keep them away from the pipe. In addition, do not operate the engine in areas where flammable materials are present.

⚠ **Connect the battery earth cable carefully!**



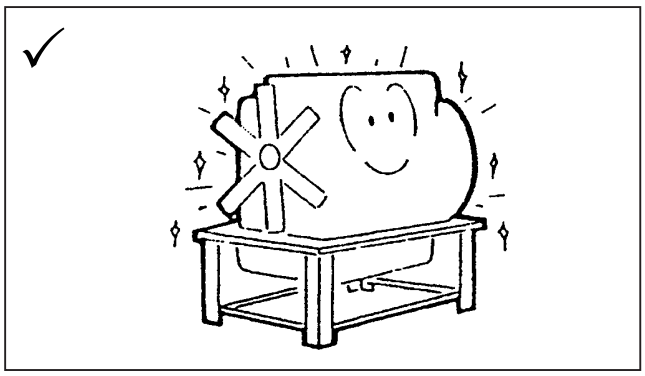
Finally, connect the earth cable (negative terminal) to the engine block, when starting the engine using another battery. If it is accidentally connected to the negative terminal of the mounted battery, a spark may occur, igniting the explosive gas produced by the battery. After starting the engine, first disconnect the earth cable.

⚠ **Always be alert to any fuel or oil leaks!**



If you discover any leaks, take counter-measures immediately. If there are fuel or oil spills on the hot engine, fire may occur, resulting in personal injury or damage to the equipment.

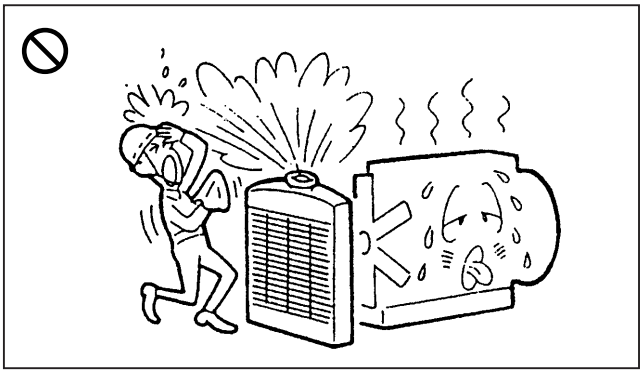
⚠ **Keep the engine and its compartment clean!**



Remove all flammable materials such as fuel, oil, and other debris, before they accumulate on the engine.

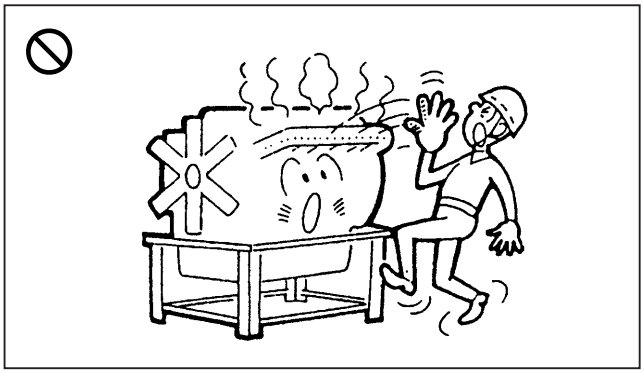
1.2 Prevent burns

⚠ **Remove the radiator filler cap carefully!**



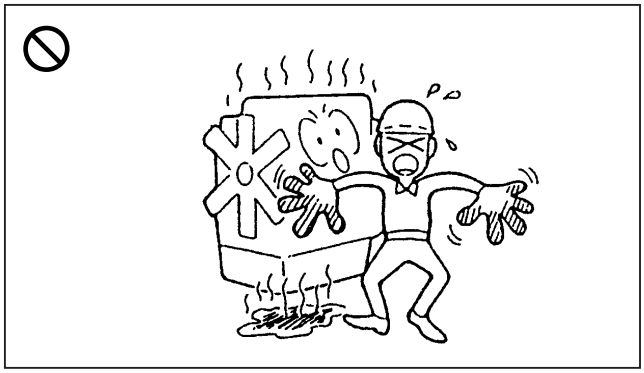
Under operating temperatures, the engine coolant is hot and under pressure. The steam can cause personal injury. Check the coolant level only after the engine has been turned off and the filler cap is cool enough to touch with your bare hands. If necessary grip the cap with a cloth and remove it slowly in order to gradually relieve the pressure.

⚠ **Do not touch any hot components!**



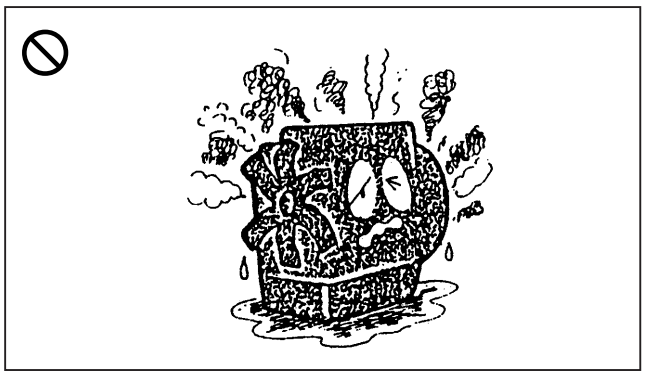
At operating temperature, the engine components become very hot. Avoid any contact during operation. Service the engine only after it has been stopped and the components are cool enough to touch with your bare hands.

⚠ **Avoid burns!**



Immediately after completing operations do not change the oil or the coolant. Hot oil or coolant may burn the skin. Allow the engine to cool down to room temperature before replacement.

⚠ **Turn off the battery switch before servicing!**

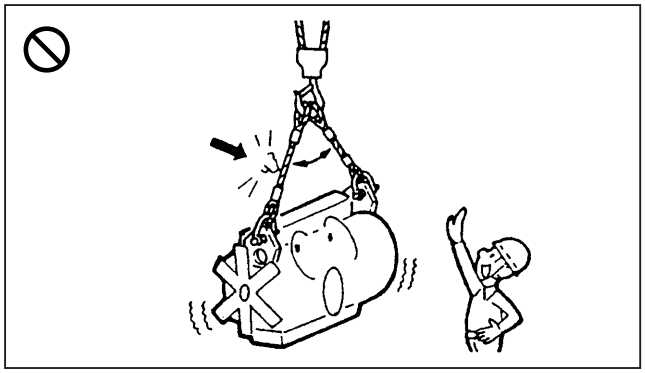


Be sure to turn OFF the battery switch before servicing.

If electrical equipment, including the starter or alternator, is serviced with the battery switch turned ON, it may be shortcircuited by the current from the battery's positive terminal, resulting in burns or in fire.

1.3 Lifting precautions

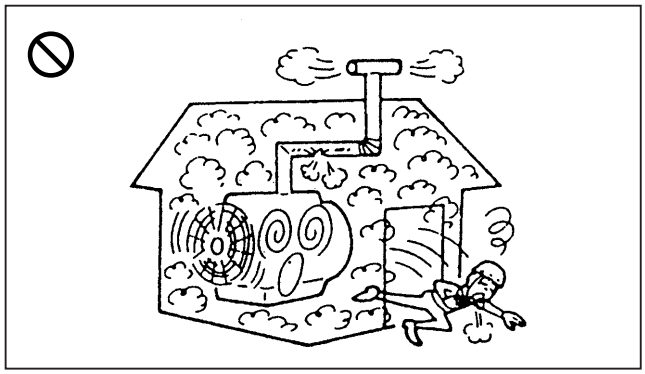
⚠ **Lift the engine carefully!**



Never allow anyone to walk or stand underneath a suspended engine. Operate the hoist carefully without jerking it. Remember, sudden impact of loads can cause serious accidents.

1.4 Exhaust fumes

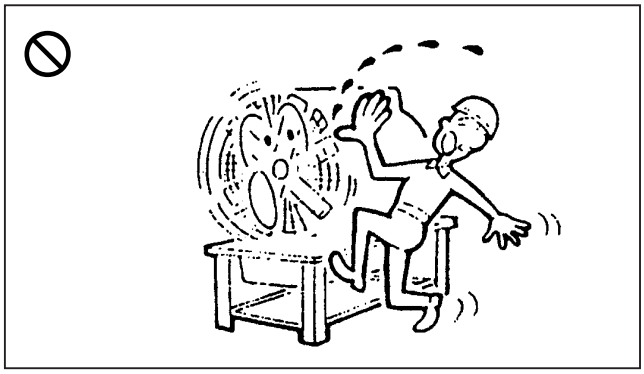
⚠ **Exhaust fumes**



Operate the engine in safe areas only! Operate the engine in a well ventilated area. Never operate it in an enclosed area. In particular, do not operate it near an air inlet port on the downwind side.

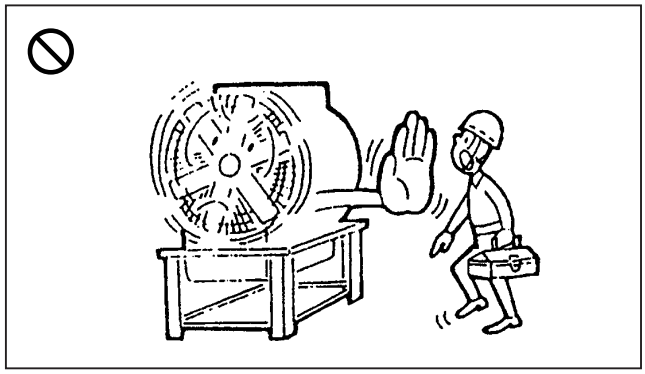
1.5 Prevention of cuts and other injuries

⚠ **Stay clear of all rotating and moving parts!**



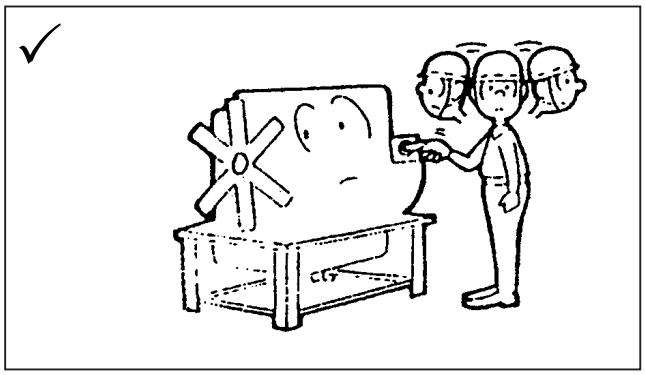
The rotating parts of the engine are dangerous. Always stay clear of them during operation.

⚠ Use care during checking and servicing!



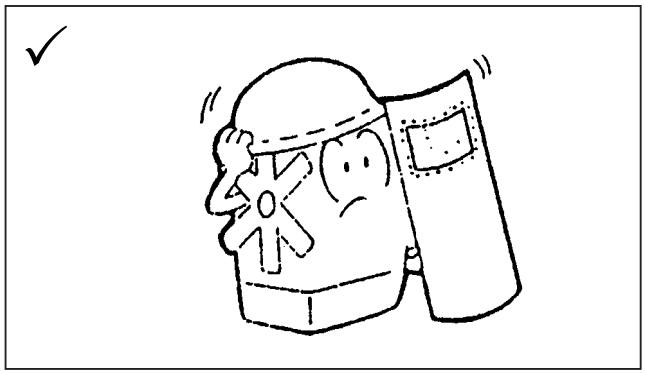
Before performing maintenance, remove the starter switch key and turn OFF the battery switch. Attach a "DO NOT OPERATE" or similar warning tag to the starter switch.

⚠ Ensure that everything is in order before restarting the engine!



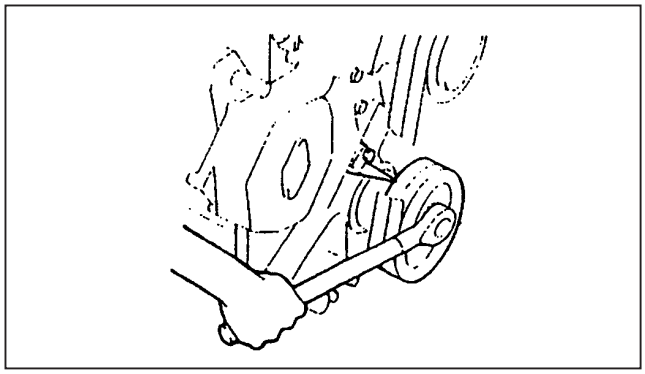
Before starting the engine, make sure that no one is working on or close to the engine. Remove all foreign material from the engine, such as debris, oil, tools, and other items which are not part of the engine.

⚠ Install the protective covers!



To prevent personal injury, make sure all protective covers and guards are placed on the rotating parts.

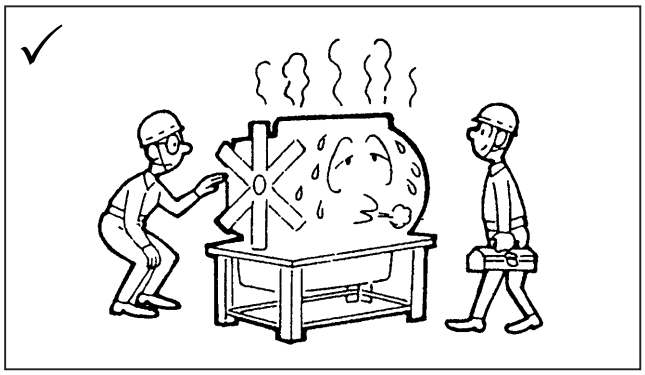
⚠ Keep the turning tool disengaged when it is not in use!



When not in use, properly lock the turning gear in the disengaged position. Failure to follow this recommendation can cause personal injury and engine damage.

1.6 Maintenance precautions

⚠ Stop the engine before servicing it!

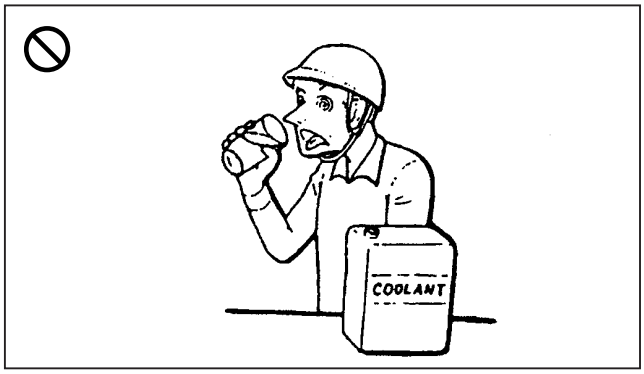


Always stop the engine before adding or changing oil, coolant, or fuel. Check the coolant level only after the engine has been stopped and the radiator filler cap is cool enough to remove it with bare hands. Never attempt to adjust the fan belt while the engine is running.

⚠ Handle battery electrolyte carefully!

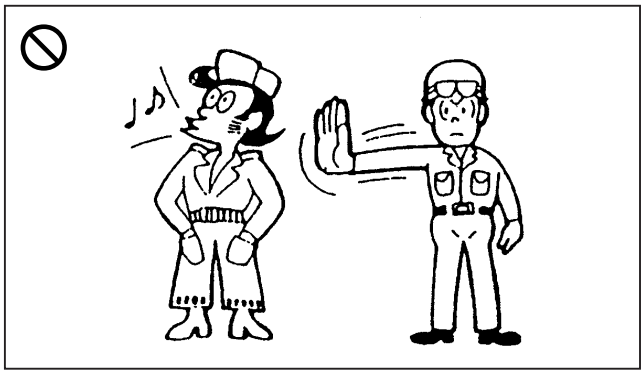
If battery electrolyte comes into contact with the eyes or skin, wash them clean immediately by using plenty of water. If it comes into contact with the eyes, wash out your eyes immediately and then see a doctor.

⚠ Handle antifreeze carefully!



If you accidentally drink antifreeze, make yourself vomit and see a doctor immediately. If antifreeze comes into contact with the eyes, immediately wash them clean by using plenty of water and then go and see a doctor.

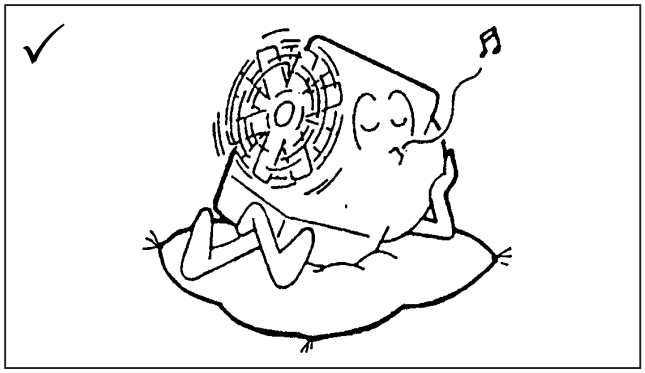
⚠ Dress properly for the job!



For your own protection, you may need any number of special items - hard hat, face shield, safety shoes, goggles, heavy gloves, ear protectors, etc. Please do use these when required.

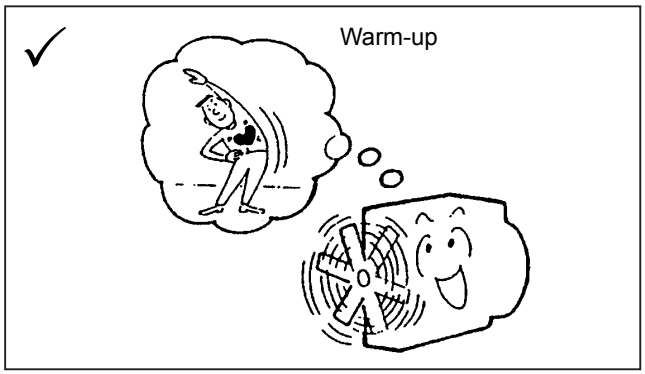
1.7 Operating precaution

⚠ **Be sure to break in the engine!**



During the first 50 hours of operation, break in the engine by using lighter loads and lower speeds than normal. A proper break in contributes to the maximum service life of the engine.

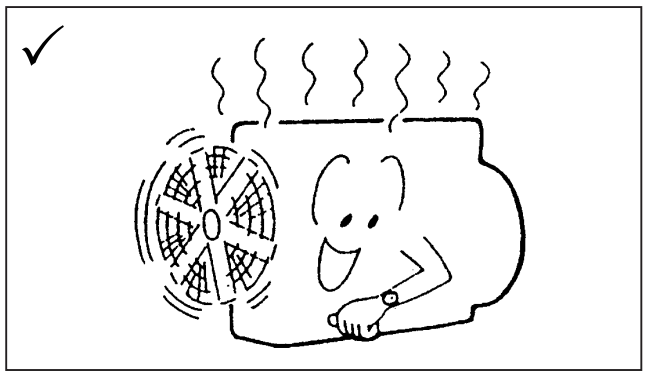
⚠ **Warm up the engine before operation!**



After starting the engine, leave it idling for 5 to 10 minutes before operating under full load, for maximum engine life.

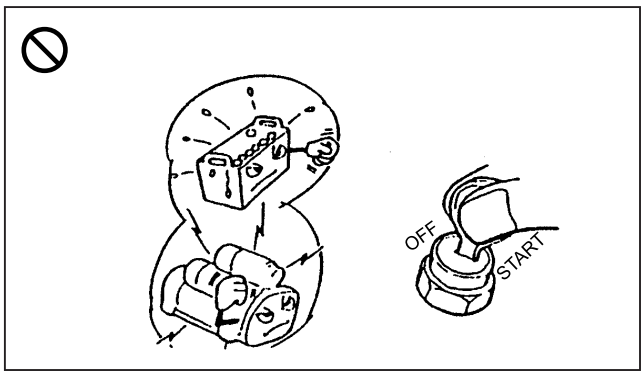
NOTE: Long periods of warming up the engine are not recommended. They can deposit carbon in cylinders and cause incomplete fuel combustion.

⚠ **Stop the engine only after it has cooled down!**



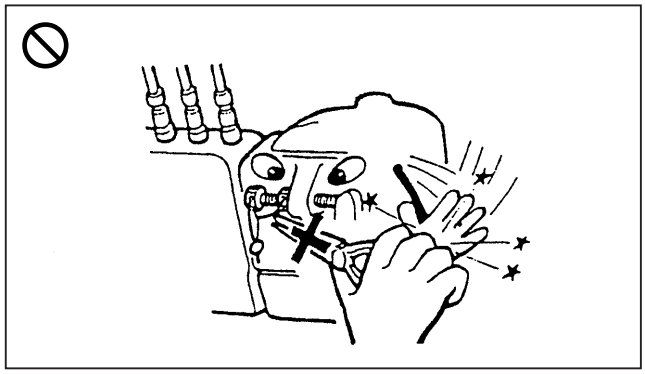
Stopping the engine immediately after it has been working under a load, can result in overheating and accelerated wear of the engine components. Before stopping the engine, leave it idling for 5 to 10 minutes. This allows the hot areas in the engine to cool down gradually, which extends engine life. While the engine is running, make a walk-around inspection to make sure everything is functioning properly.

⚠ **Use the starting motor correctly!**



When starting the engine, do not crank it for more than 10 seconds at a time. After every 10 seconds of engine cranking, allow 30 seconds for the starting motor to cool before cranking it again.

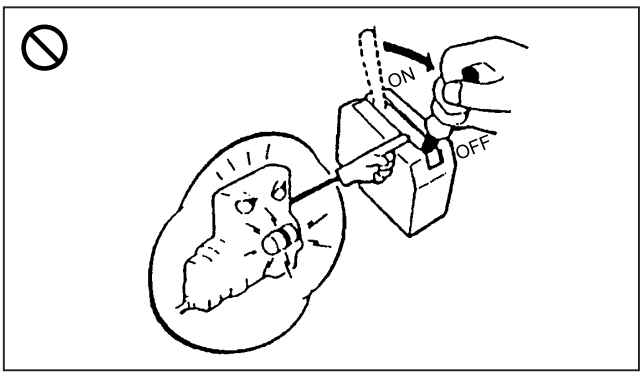
⚠ Do not break any seals for settings!



Never attempt to break the seals of the fuel injection pump (governor) controlling injection quantity and minimum and maximum speed settings. Breaking these seals and varying settings could result in:

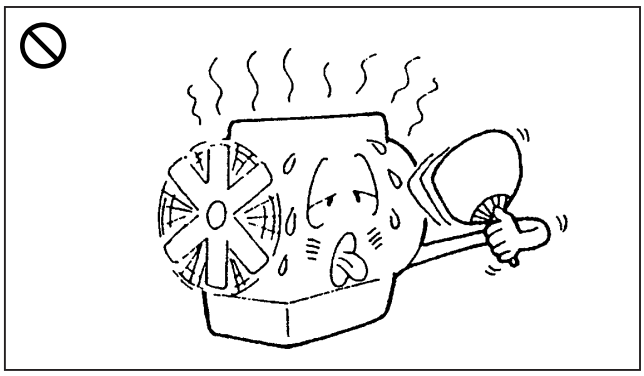
- Accelerated wear of the engine components
- Seizure of or damage to the engine components
- Increase in fuel and oil consumption
- Maladjusted injection quantity and poor engine performance
- Violation to emission regulations

⚠ Do not turn OFF the battery switch during operation!



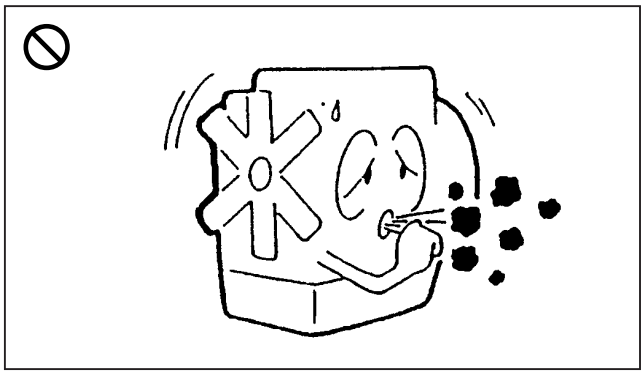
To avoid damage to the alternator diodes and the transistors, do not turn OFF the battery switch when the engine is running. This could also result in a failure of instruments to work properly.

⚠ Always keep the engine compartment well ventilated!



Unless the engine compartment is properly ventilated, the air supply will be inadequate, resulting in a shortage of air for fuel combustion and the loss of power.

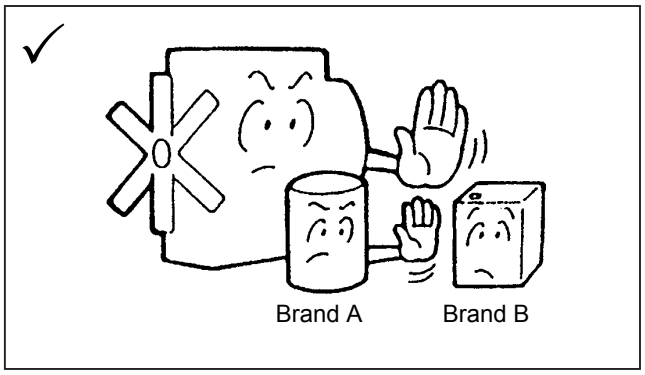
⚠ Avoid overloading!



Overloading can cause incomplete combustion, often indicated by black smoke, high fuel consumption, and carbon deposits in the combustion chambers, adversely affecting the engine lifespan.

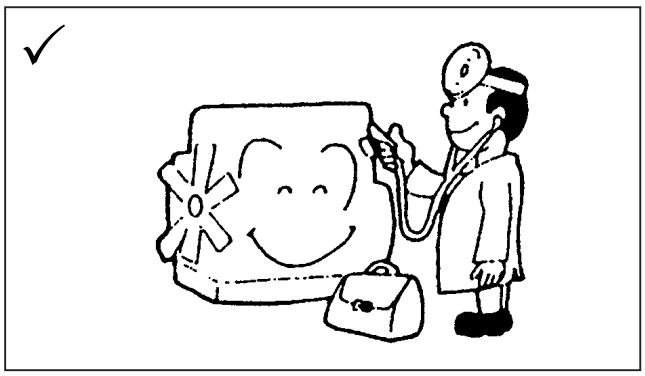
1.8 Maintenance precautions

⚠ **Use the recommended fuel, oil, and coolant!**



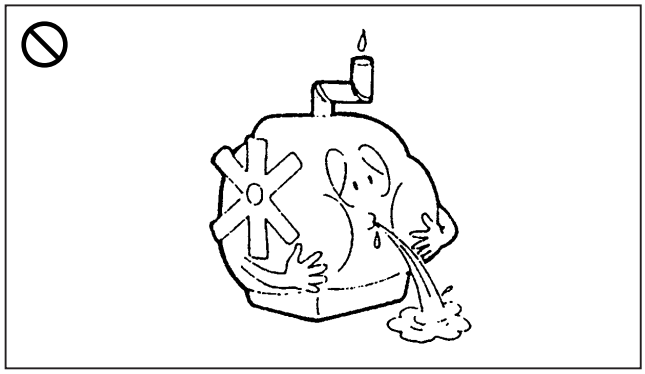
Use of any other fuel, oil, or coolant can cause engine damage and reduce the engine service life.

⚠ **Perform all recommended inspections!**



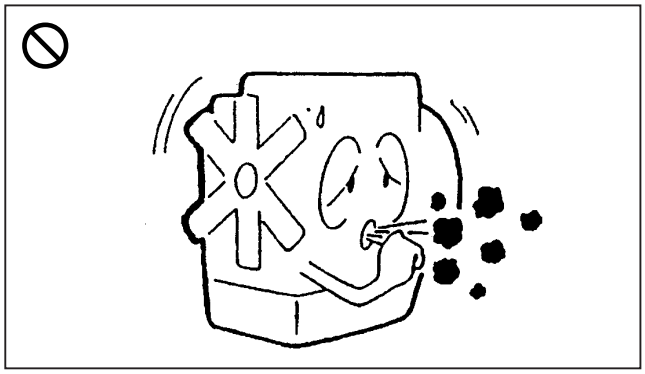
Perform pre-start inspection and periodic inspection on items listed in this manual. Failure to follow this recommendation can cause engine damage, injury, or death.

⚠ **Keep water out of the engine!**



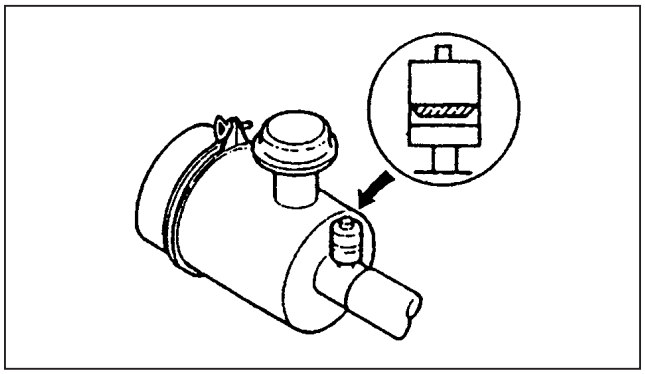
When washing the engine, cover the air inlet and exhaust opening with tape to prevent water or cleaning agent from getting inside the engine. Do not wash the engine while it is running. If water or cleaning agents get inside the combustion chambers, the hammering action of water can damage the engine.

⚠ **Keep grit-laden air out of the engine!**



Dust and dirt entering the engine will cause early wear of the moving parts. This could result in a loss of power, high oil consumption, starting problems, or other failures. Service the air filter as instructed.

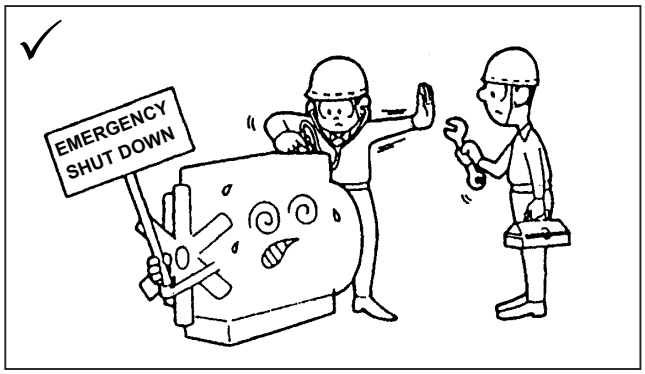
1. Do not service the air filter while the engine is running.
2. When removing the air filter element for service, prevent any dust from entering the air intake to the cylinders.



3. Service the air filter equipped with a dust indicator when red is shown. Under-frequent service can cause damage.

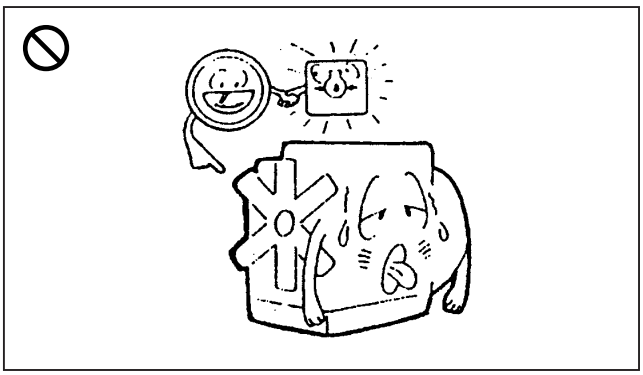
1.9 If any trouble should occur

⚠ If the engine suddenly stops:



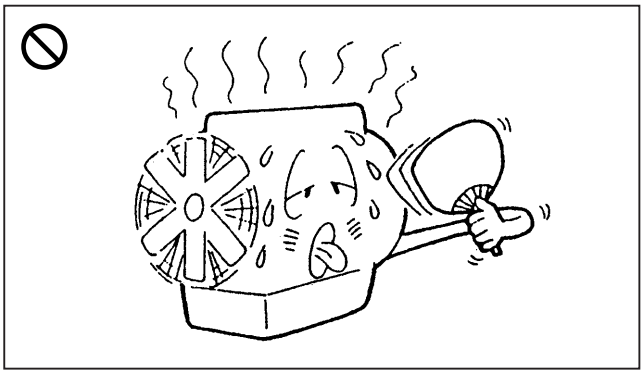
Do not restart the engine immediately after it has suddenly stopped. Check for the cause and make the necessary repairs before restarting the engine. A failure to follow this precaution can cause serious engine problems.

⚠ If the engine oil pressure is low:



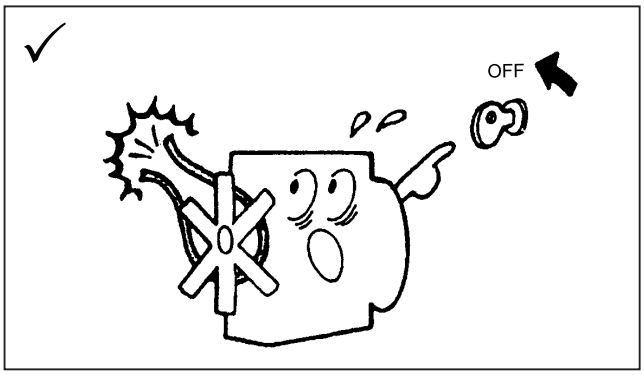
Stop the engine immediately and check the lubrication system. Operating the engine with low oil pressure can cause bearings and other parts to seize.

⚠ If the engine overheats:



If the engine overheats, do not turn it off immediately. Suddenly stopping an overheated engine can result in a steep rise in the coolant temperatures and the seizure of running parts. First leave the engine idling to allow the hot areas in the engine to cool down, then gradually add the coolant. Remember, adding coolant to an overheated engine can cause damage to the cylinder head.

⚠ If the fan belt is broken:



Stop the engine immediately. Operating the engine with a broken fan belt can cause engine overheating, which, in its turn, can cause the coolant to burst out of the reservoir tank and the radiator cap.

2 IMPORTANT INFORMATION

2.1 Operating the engine properly

1. Never attempt to break the seals of the injection pump governor for maximum speed and maximum injection quantity settings. Breaking these seals and varying the settings could result in:
   - Accelerated wear of engine components
   - Increase in fuel and oil consumption
   - Maladjusted injection quantity and poor engine performance
   - A violation to emission regulations
2. Always keep the engine room well ventilated. If it is not properly ventilated, the air supply will be inadequate, resulting in lack of air for fuel combustion and loss of power.
3. Start the engine properly. After every 10 seconds of engine cranking, allow 30 seconds for the starting motor to cool before cranking it again.
4. After starting the engine, leave it idling for 5 to 10 minutes before operating it at full load, for maximum engine life.

> ⚠ **NOTE**
> Long periods of warming up the engine are not recommended. They can result in carbon deposits in the combustion chambers and incomplete fuel combustion.

5. To avoid damage to the alternator, do not turn OFF the battery switch when the engine is running.
6. Avoid overloading. Overloading can cause incomplete combustion, often indicated by black exhaust, high fuel consumption, and carbon deposits in the combustion chambers, affecting engine lifespan.
7. It is advised to break in the engine within the first 50 hours of operation. The way to do this is by operating the engine under a lighter load and lower speeds than normal. When an engine is properly broken in, it contributes to the maximum service life of the engine.
8. Stopping the engine immediately after it has been working under load can result in accelerated wear of engine components. Before stopping, leave the engine idling for about 5 minutes. This allows hot areas of the engine to cool down gradually, extending the engine life. Whilst the engine is running, make a walk-around inspection and check for oil, fuel, or coolant leaks.

2.2 Service the engine properly

1. Use the recommended fuel, oil, and coolant listed in this manual. The use of any other fuel, oil, or coolant can result in higher maintenance costs and can reduce the engine service life.
2. Be sure to perform pre-start inspection and periodic service on items specified in this manual. Improper inspection or service is dangerous and could result in damage to the engine, injury, or death.
3. At the end of each day of operation, check the engine for broken, defective, or missing parts. If you discover any items that need attention, repair, replacement, or adjustment after your daily check, report it as soon as possible. Keep in mind that even minor defects could result in very serious trouble.
4. When washing the engine, cover the air inlet and the exhaust openings with tape to prevent water or cleaning agent from getting inside the engine. Do not attempt to wash the engine when it is running. If water or cleaning agent gets inside the combustion chambers, the hammering action of water could cause damage to the engine.
5. Clean air is essential to a satisfactory engine operation and to a long engine life. This is also the reason why it is very important to service the air cleaner properly. The air cleaner prevents dust and grit-laden air from getting into the engine. Dust and dirt entering the engine will cause rapid wear of piston rings, cylinders, and pistons, resulting in loss of power and high oil consumption. Also, if dust and dirt are allowed to build up in the air cleaner passages, then this will eventually restrict the air supply to the engine and result in heavy carbon deposits on the pistons and valves due to an incomplete combustion. Therefore:
   - Do not service the air cleaner when the engine is running.
   - When removing the air cleaner from the engine for servicing, prevent dust from entering the air passage to the cylinders.
   - Service the air cleaner element at reasonable intervals, or whenever the signal of the indicator is visible. That is, if your engine is equipped with an indicator signal.
   - Do not use the element if any tears, rips, or damage are evident.

2.3 If any trouble should occur

1. If the engine stops abruptly, try to find the problem and its source and make the necessary repairs before starting the engine again.
2. If the engine overheats, a warning light will come on and, at the same time, the engine will stop. When this happens, do not ever add coolant to the overheated engine. First allow the engine to cool down, then add the coolant gradually.
3. If the engine oil pressure becomes low, stop the engine and check for the cause. Operating the engine while the oil pressure is low can cause seizure of the bearings and other parts.

3 SPECIFICATIONS[1]

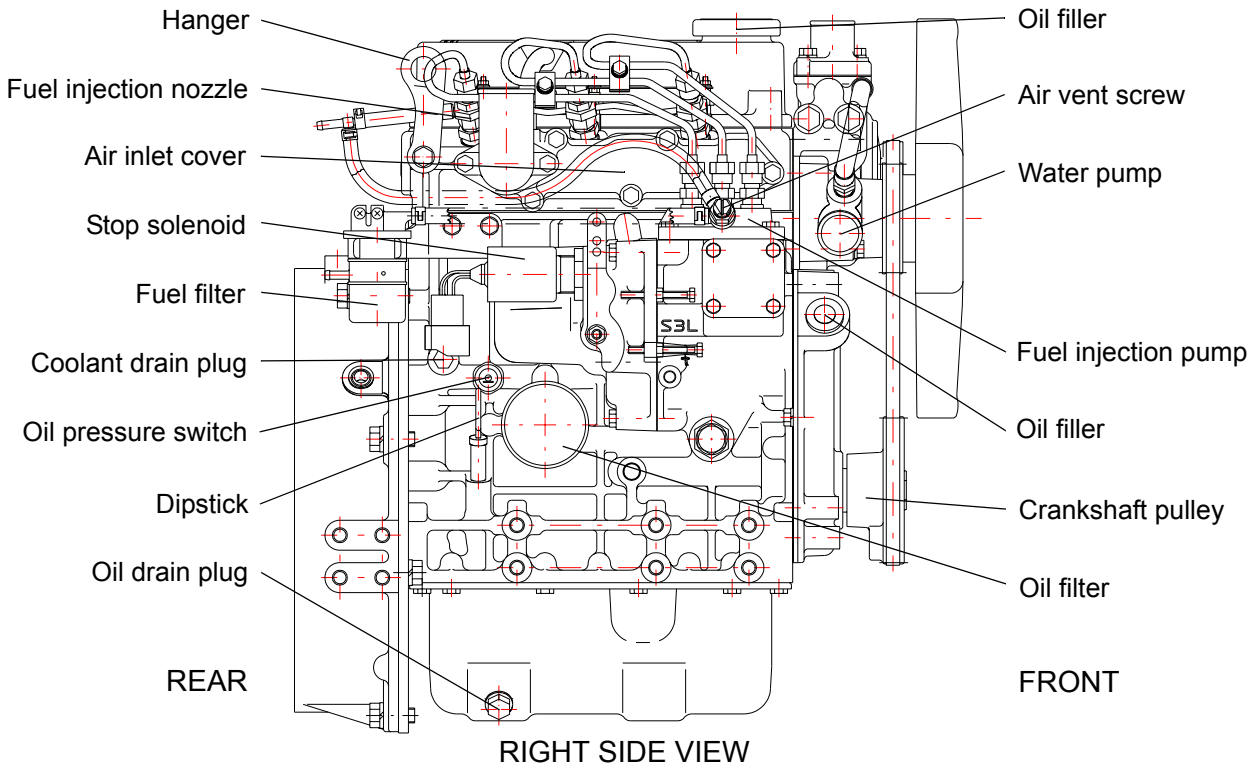
System	Item	Model							
		S3L	S3L-T	S3L2	S3L2-T	S4L	S4L-T	S4L2	S4L2-T
ENGINE PROPER	Type	4-cycle, water-cooled, vertical, overhead valve, diesel engine							
	Combustion chamber	Swirl chamber type							
	No. of cylinders	3				4			
	Bore x Stroke (mm)	78x78.5		78x92		78x78.5		78x92	
	Total displacement (*l*)	1.125		1.318		1.500		1.758	
	Compression ratio	22							
	Firing order	1-3-2				1-3-4-2			
	Dry weight (kg)	135	139	135	139	155	159	155	159
LUBRICATING SYSTEM	Lubricating method	Forced lubrication							
	Oil pump	Trochoid pump							
	Oil filter	Paper element type							
	Oil capacity: FULL level/EMPTY level (*l*) (Exclusive of oil filter capacity 0.5 *l*)	Shallow type oil pan: 3.7/2.3 Deep type oil pan: 5.7/3.1				Shallow type oil pan: 5.5/3.7 Deep type oil pan: 7.6/4.2			
FUEL SYSTEM	Fuel injection pump	Bosch M							
	Nozzle	Throttle type							
	Fuel injection pressure	140 kgf/cm^2							
	Fuel to be used	Diesel fuel; see chapter 7							
	Governor	Centrifugal weight type							
INTAKE SYSTEM	Air cleaner	Paper-element type							
	Turbocharger model	Without	TD025	Without	TD025	Without	TD025	Without	TD03
COOLING SYSTEM	Cooling method	Forced circulation of water							
	Water pump	Centrifugal type							
	Coolant capacity (*l*) (Engine proper only)	1.8				2.5			
ELECTRICAL SYSTEM	Starter (V - kW)	12 - 1.6 or 12 - 1.7 or 12 - 2.0							
	Alternator (V - A)	AC generator (12 - 50)							
	Glow plug	Sheathed type							
	Battery (capacity depends on application)	12V, 65 Ah or more				12V, 80 Ah or more			

Table 1 Specifications

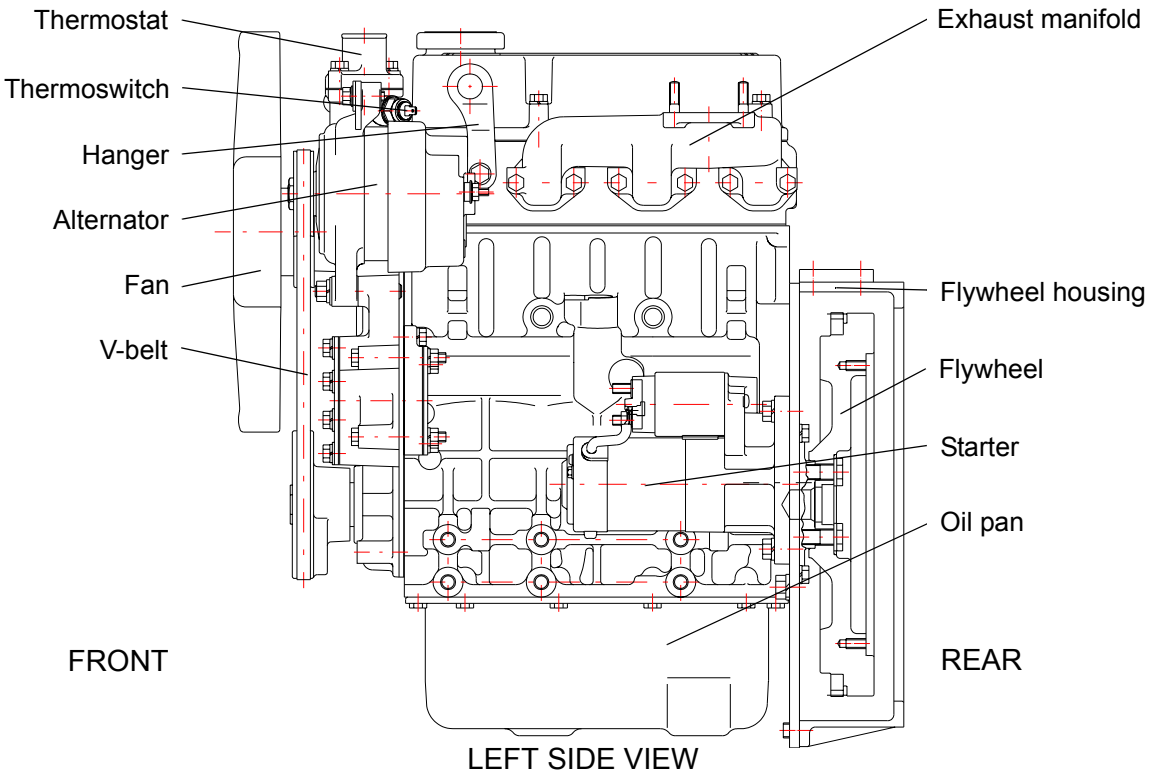
1 All specifications are subject to change without any prior notice.

4 NOMENCLATURE

4.1 Engine S3L/S3L2

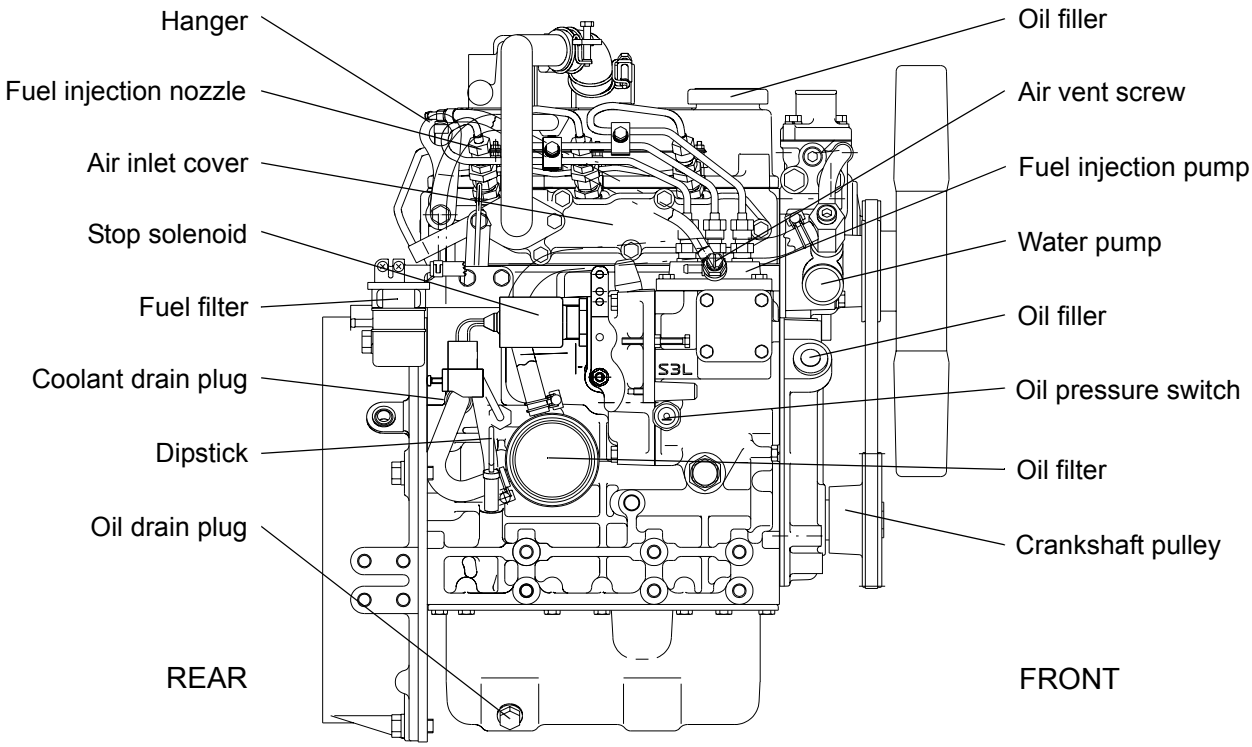


RIGHT SIDE VIEW

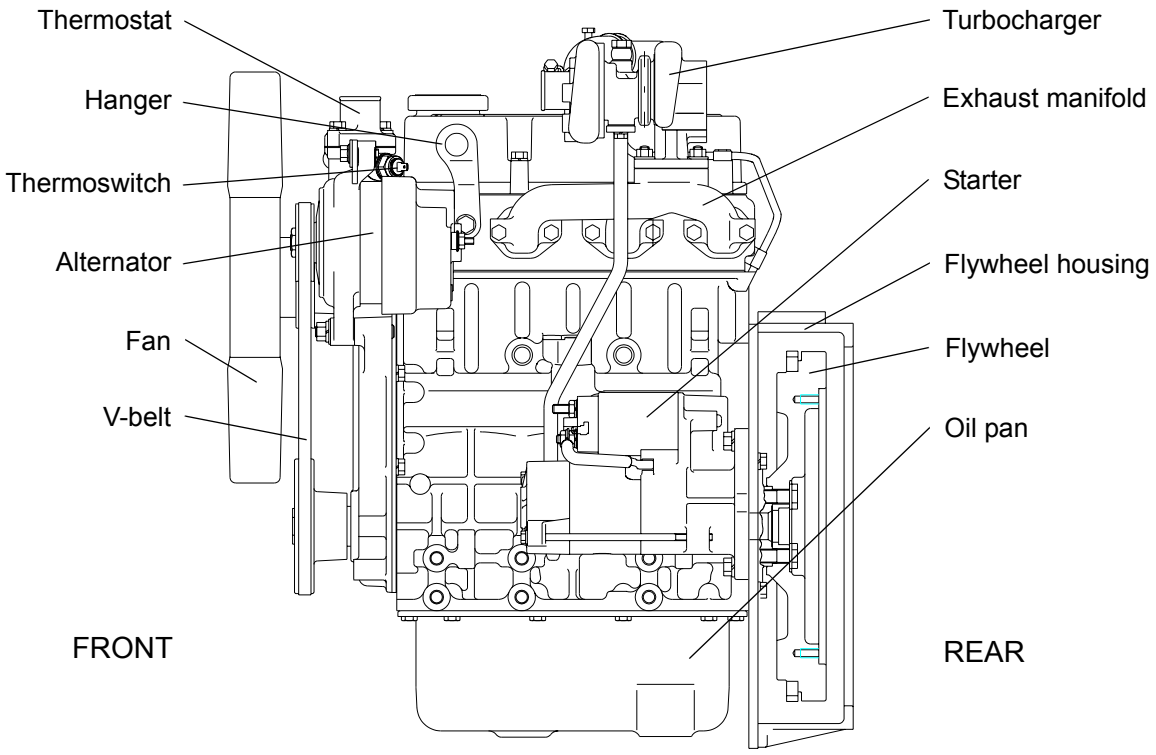


LEFT SIDE VIEW

4.2 Engine S3L-T/S3L2-T



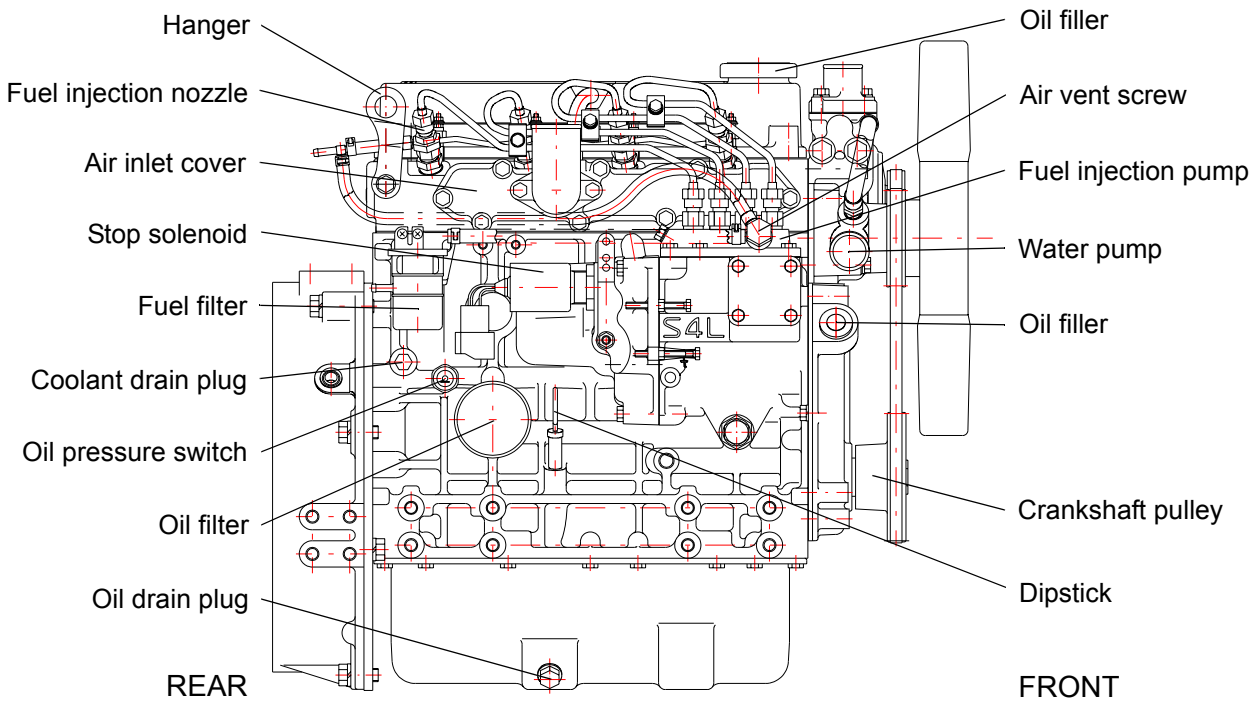
RIGHT SIDE VIEW



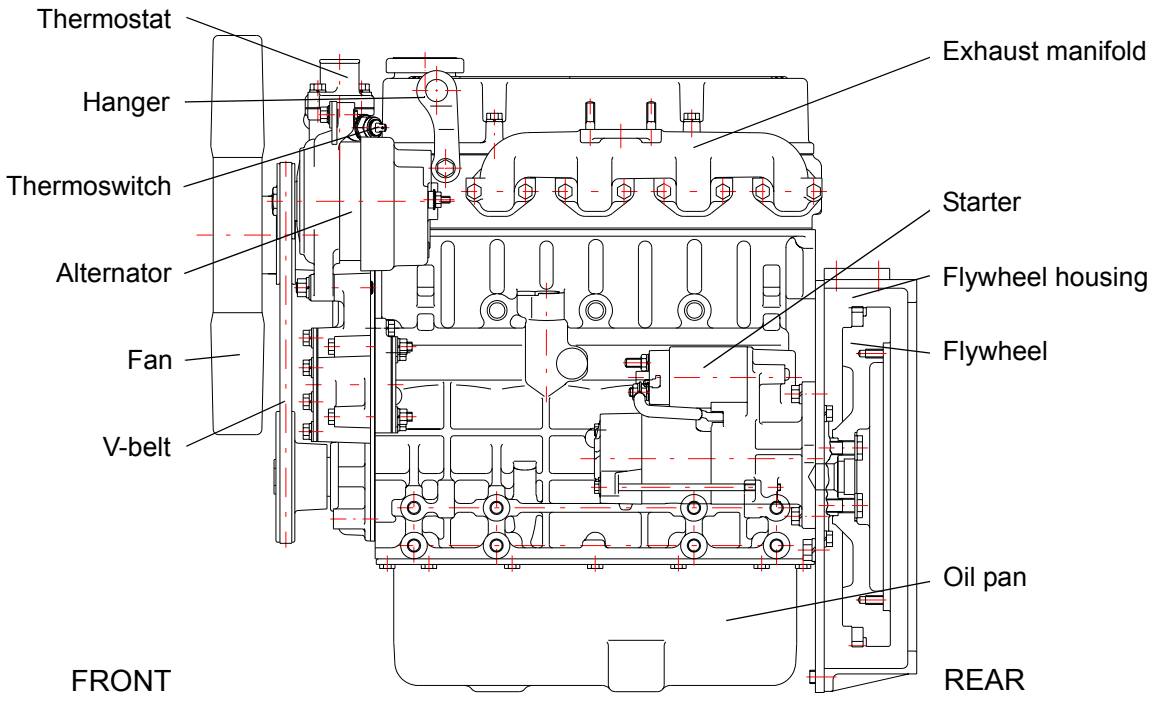
LEFT SIDE VIEW

NOMENCLATURE

4.3 Engine S4L/S4L2

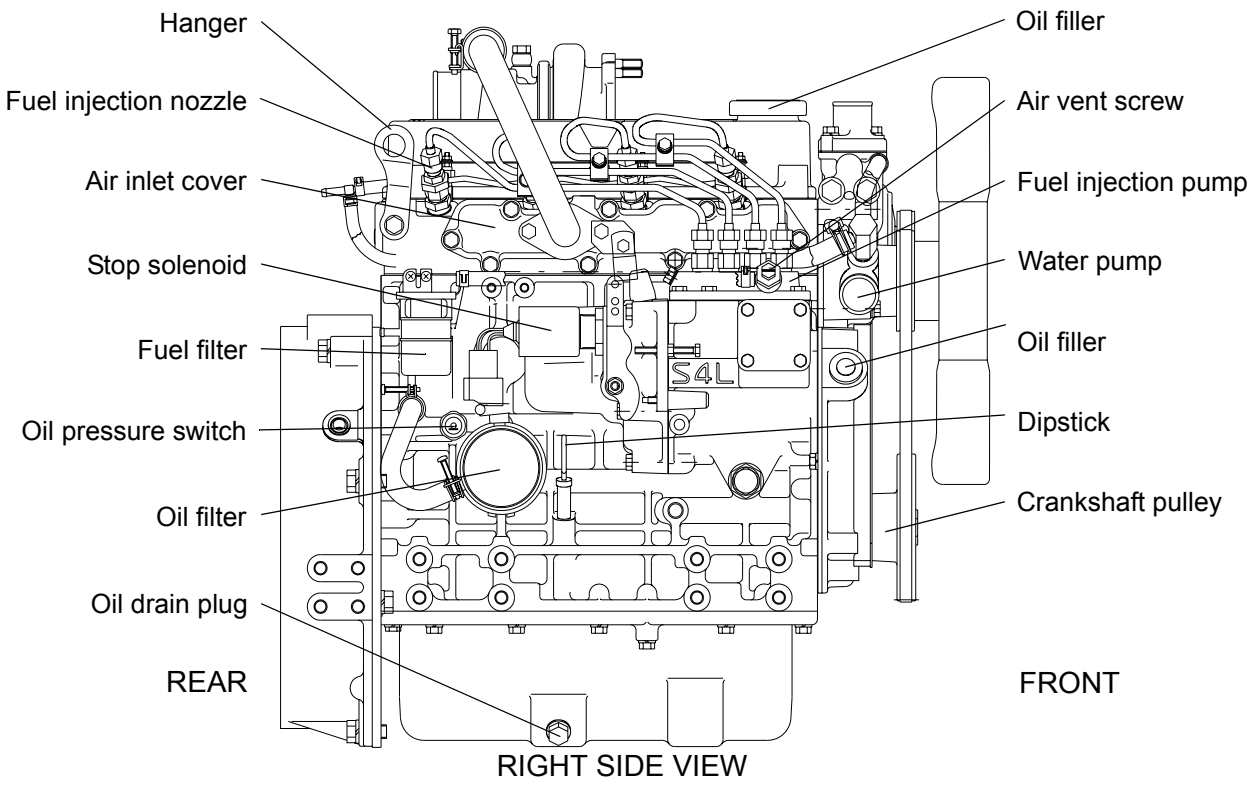


RIGHT SIDE VIEW

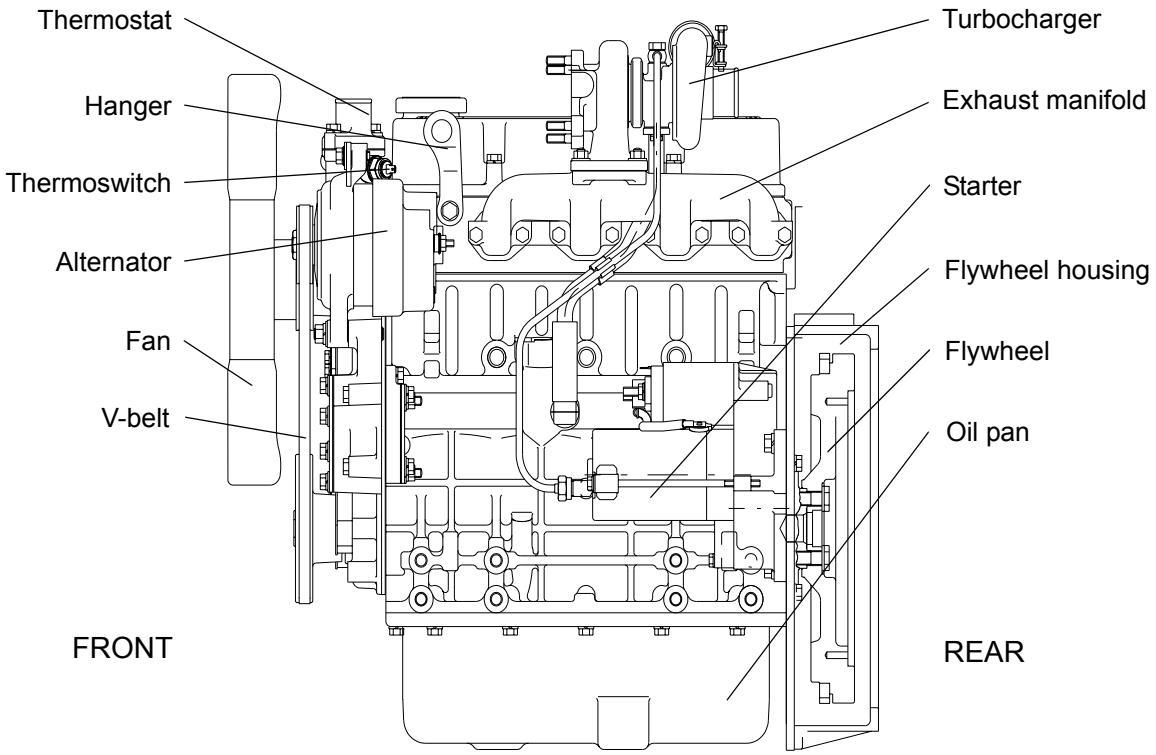


LEFT SIDE VIEW

4.4 Engine S4L-T/S4L2-T



RIGHT SIDE VIEW



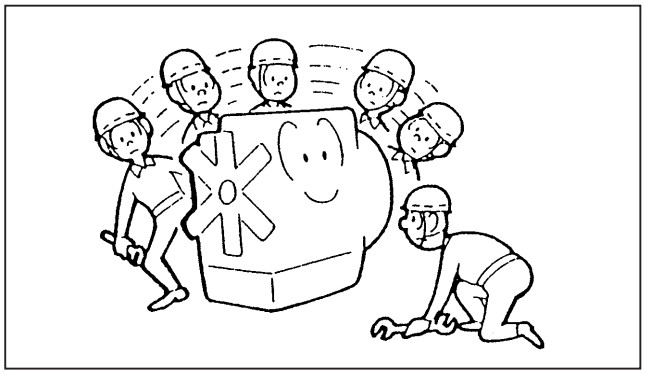
LEFT SIDE VIEW

5 OPERATION

5.1 Pre-start inspection

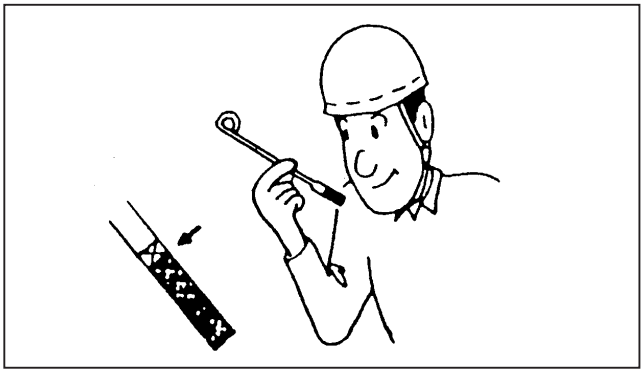
5.1.1 Walk-around Inspection

Look around for items such as loose bolts, debris build-up, oil, fuel, or coolant leaks, broken or worn parts.



5.1.2 Check engine oil level

Maintain the engine oil level between the MAX and MIN marks on the dipstick. Add oil if necessary (see page 34).

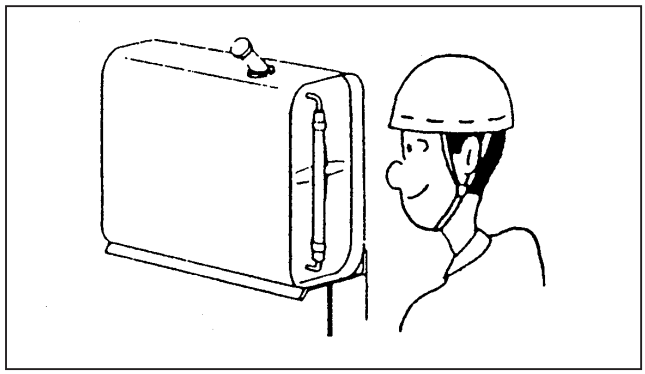


⚠ NOTE

The engine should be put in the horizontal position to check the oil level. The dipstick should be withdrawn, wiped clean, re-inserted in the oil level guide for 2 seconds, and again withdrawn so that the oil level on the dipstick can be seen.

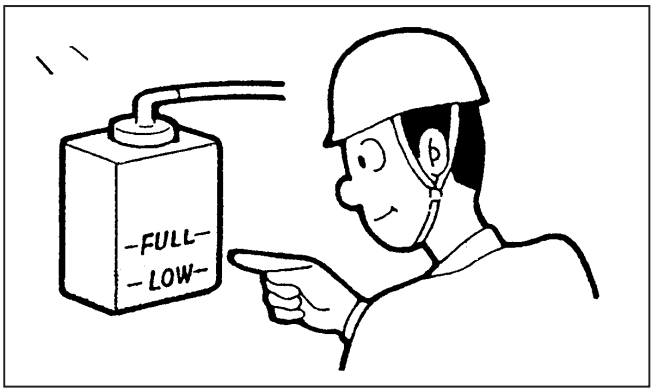
5.1.3 Check fuel level

Make sure that the fuel level is at the FULL mark in the sight gauge.



5.1.4 Check the coolant level

Maintain the coolant level to the FULL mark on the reservoir tank (when the engine is cold). Add coolant when necessary.



⚠ NOTE

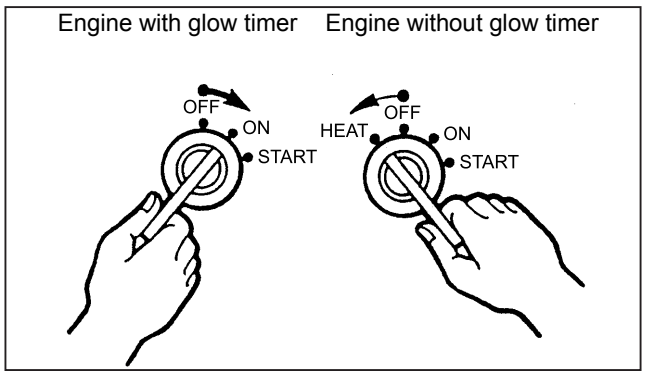
When adding coolant, maintain the recommended concentration of Long Life Coolant (see page 36). Do not add water. This dilutes Long Life Coolant and adversely affects the freeze protection.

⚠ CAUTION

Check the coolant level only when the engine is cold.

5.2 Starting the engine

The engine can be equipped with or without a glow timer. For starting instructions, please consult the chapter which specially applies to your engine.



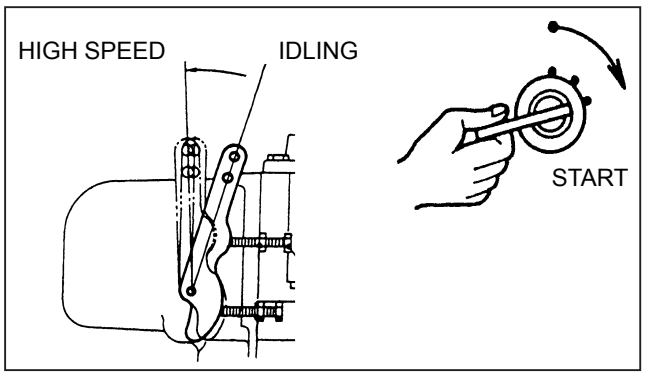
5.2.1 Engine with glow timer

1. Move the speed control lever to the HIGH SPEED position.
2. Turn the starter switch key to the ON position and make sure that the oil pressure, coolant temperature, and glow plug indicators are lit. See Table 2 Starting Aid Chart for heating time.

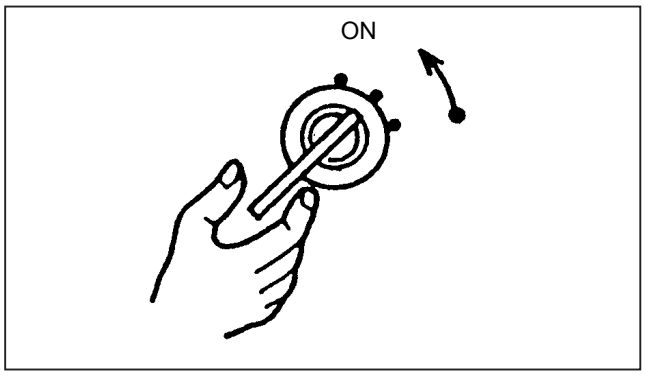
Glow plug type	Coolant temperature	Heating time
Quick-heating type	Below 5°C (41°F)	About 3 seconds
	Above 5°C (41°F)	About 1 second
Standard type	Normally	About 6 seconds

Table 2 Starting Aid Chart

3. When the glow plug indicator goes off, turn the key to the START position.



4. Release the key when the engine starts. The key will return to the ON position when released.



5. Move the speed control lever to the idling position.

5.2.2 Engine without glow timer

1. Move the speed control lever to the FULL THROTTLE position.
2. Turn the starter switch key to the HEAT position and continue to hold it there for approximately 6 seconds. Do not use the glow plugs for more than 15 seconds at a time.
3. Turn the key to the START position and release the key when the engine starts. The key will return to the ON position when released.
4. Move the speed control lever to the idling position.

⚠ WARNING

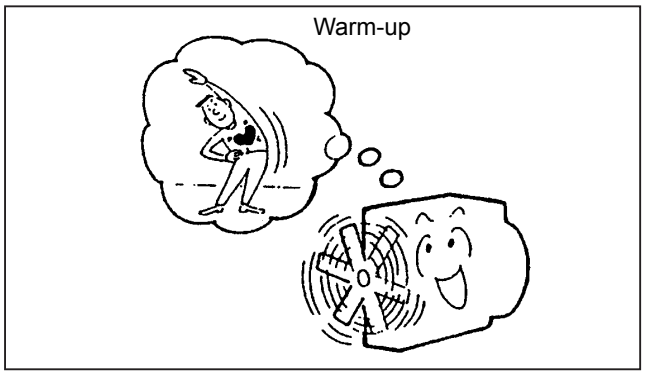
Before starting the engine, make sure that no one is working on or close to the engine. Keep the engine free of foreign material such as debris, oil, tools, and other items which are not part of the engine.

⚠ CAUTION

- After every 10 seconds of engine cranking, allow 30 seconds for the starter to cool down before cranking again.
- To avoid damage to the starter, do not turn the starter switch key to the START position while the engine is running.
- When cranking the engine for starting, do not apply any load to the engine (disengage the clutch if the engine is equipped with a clutch).

5.3 Warming up the engine

Allow the engine to leave it idling for 5 to 10 minutes. A proper warm-up is absolutely essential to a maximum service life and performance and it minimalizes the operation costs of the engine.



⚠ NOTE

Long periods of warming up the engine are not recommended. They can result in carbon deposits in the combustion chambers and incomplete fuel combustion.

5.4 Starting the load

When the engine has been running long enough to warm up, apply the load. During the operation, check that:

1. All alarm indicators are OFF.
2. The engine is free from any abrupt noises and vibrations.
3. Exhaust smoke is normal.

⚠ WARNING

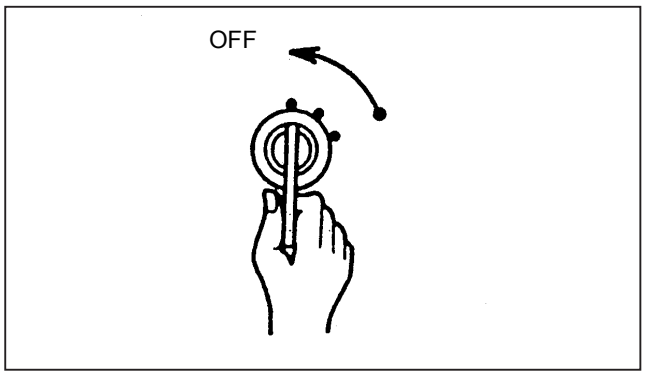
- Stay clear of all rotating and moving objects during the operation.
- At operating temperature, the engine is very hot. Any contact with the engine can cause severe burns.

⚠ CAUTION

- Always keep the engine room well ventilated. Unless it is properly ventilated, the air supply will be inadequate, resulting in lack of air for fuel combustion and a loss of power.
- During the first 50 hours of operation, operate the engine under a lighter load and lower speed than normal. A proper break in contributes to the maximum service life of the engine.
- Avoid overloading. This can cause incomplete combustion, often indicated by black exhaust smoke, high fuel consumption, and carbon deposits in the combustion chambers, affecting the engine's lifespan.
- To avoid damage to the alternator, do not turn OFF the battery switch when the engine is still running.
- To avoid damage to the starter, do not turn the starter switch key to the START position when the engine is still running.

5.5 Stopping the engine

5.5.1 Engine with a keystop device



Turn the starter switch key to the OFF position. The engine will take approximately 5 seconds to stop after the key has been turned to the OFF position.

⚠ NOTE

If the electrical system includes a control timer for engine shutdown, the starter switch should be kept in the "OFF" position for at least 10 seconds before making another start attempt (to restart the engine once the engine stopped or has been stopped) in order to reset the control timer automatically.

⚠ CAUTION

- Leave the engine idling for 5 minutes. This allows hot areas in the engine to cool down gradually, which extends engine life. While the engine is still running, make a walk-around inspection, and check for oil, fuel, or coolant leaks.
- If the engine stops abruptly, try to find the problem and its source and make the necessary repairs before starting it again. After starting the engine, check to be sure that the engine has no problems.
- Remove the key from the starter switch, because leaving it in the ON position after the engine has stopped, can cause the battery to discharge.

6 MAINTENANCE

1. Service the engine in accordance with the "Lubrication and Maintenance Chart." Under extreme, severe, or dusty operating conditions, service the engine more frequently than is specified in the "Lubrication and Maintenance Chart."
2. Perform service on items at multiples of the original requirement. For example, at Every 500 Service Hours, also service those items listed under Every 250 Service Hours, Every 100 Service Hours, Every 50 Service Hours and Every 10 Service Hours [pre-start inspection].
3. For special items marked with an asterisk (*), rely on the expert knowledge of the service men and the service facilities offered to you at your Mitsubishi dealer.

Interval	Item	Remarks (specifications)	Page
Every 10 Service Hours [Pre-Start Inspection]	Walk-around inspection		21
	Check engine oil level		21
	Check fuel level		21
	Check coolant level		21
Every 50 Service Hours	Drain water and sediment from the fuel tank and water separator		26
	Check the battery electrolyte level and specific gravity		26
First 50 Service Hours of New or Reconditioned Engine	Change engine oil	See SPECIFICATIONS (page 16)	27
	Change oil filter		27
	Retighten nuts and bolts		*
Every 100 Service Hours	Clean fuel filter element	After cleaning, prime (page 31)	27
	Clean radiator fins		27
Every 250 Service Hours or once a year (whatever comes first)	Change engine oil	See SPECIFICATIONS (page 16)	27
	Change oil filter		27
Every 500 Service Hours	Check and adjust valve clearance	0.25 mm (0.0098 in.) for both inlet and exhaust valves	*
	Change fuel filter element	After changing, prime (page 31)	28
	Check and adjust injection pressure	140 kgf/cm^2 (1 991 psi) [13 729 kPa]	*
	Check and adjust fan belt	Deflection: 13 mm (0.5 in.)	28
	Check glow plugs		*
Every 1000 Service Hours	Retighten nuts and bolts		*
	Check starter		29
	Check alternator		29
	Check turbocharger		*
Every 2 Years	Change coolant	See SPECIFICATIONS (page 16)	29

Table 3 Lubrication and maintenance charts

Interval	Item	Remarks (specifications)	Page
When Required	Prime fuel system		31
	Clean air cleaner element		31
	Change air cleaner element		31

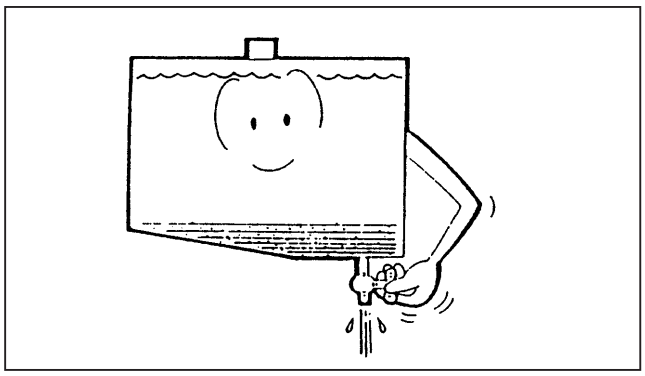
Table 3 Lubrication and maintenance charts

6.1 Every 50 service hours

6.1.1 Drain water and sediment from the fuel tank and water separator

Remove the drain plug and allow any water and sediment to drain. Drain at least 1 or 2 liters (0.3 to 0.5 U.S. gal) of fuel to remove the water and sediment.

It is evident that invisible particles of dirt in sediment which might pass through the filter will damage the finely finished parts of the fuel injection system.



⚠ DANGER

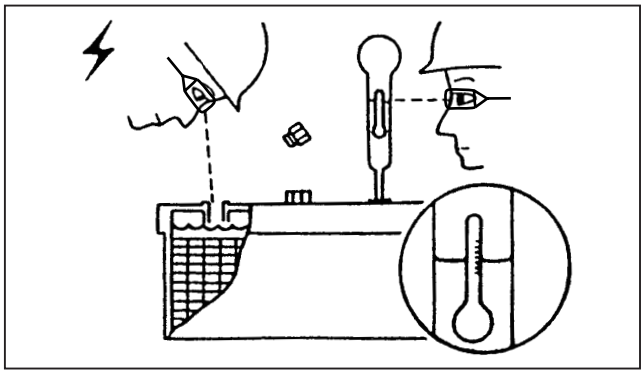
Do not smoke while draining out the water and sediment. Keep flames and sparking devices away from this area. Clean up any spillage before starting the engine.

6.1.2 Check the battery electrolyte level and specific gravity

1. Maintain the electrolyte level between UPPER and LOWER marks on the case. If the battery has not got any level marks, maintain the level 10 to 15 mm (0.4 to 0.6 in.) above the cells. Remove the filler caps and add distilled water when necessary.
2. Test the specific gravity of the battery electrolyte with a battery hydrometer. The following chart of specific gravity reading gives a general idea of the battery condition.

Specific gravity at 20°C (68°F)	Battery condition
1.26 to 1.28	Fully charged
1.22 to 1.26	Three-fourths charged (To be recharged)
Below 1.22	One-fourth charged (To be recharged)

Table 4 Specific gravity reading



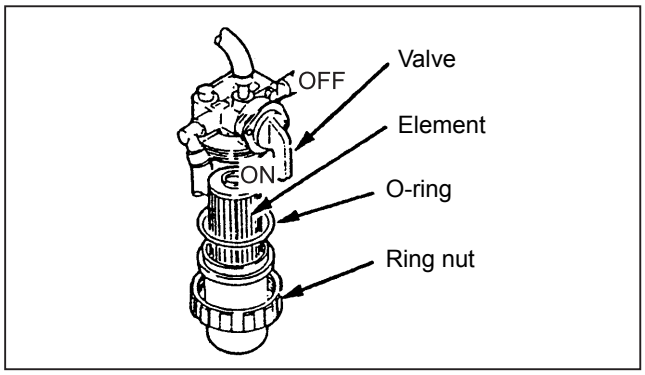
⚠ WARNING

- Battery gives off flammable fumes that are explosive.
- Do not smoke when observing the battery electrolyte level.
- Electrolyte is an acid and can cause personal injury if it comes into contact with the skin or eyes.
- Always wear goggles when working with the battery.

6.2 Every 100 service hours

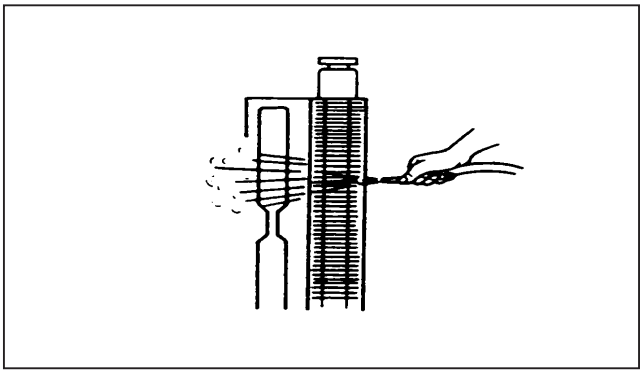
6.2.1 Cleaning the fuel filter with cut off valve

1. Turn the valve to the OFF position.
2. Loosen the ring nut and remove the cup.
3. Wash the element in kerosene or diesel fuel.
4. Put the cleaned element in the cup and install the cup, making sure the O-ring is properly fitted into place. Tighten the ring nut.
5. Turn the valve to the ON position and prime the fuel system (see page 31).



6.2.2 Clean the radiator

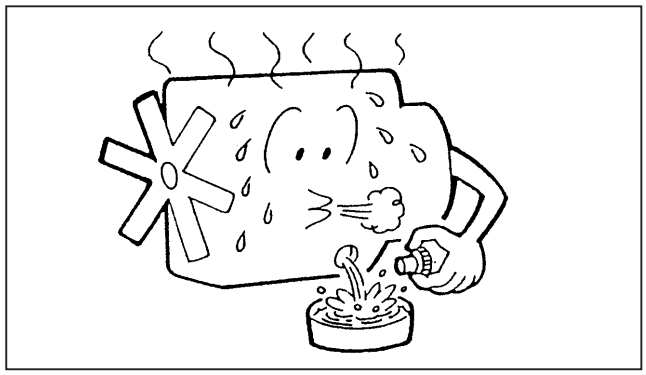
Direct the pressurized air to the fins in the opposite direction of the fan's air flow.



6.3 Every 250 service hours or once a year

6.3.1 Change engine oil and oil filter; draining oil

To avoid burns, drain the oil after the engine has cooled down to the extend that it can be touched with your bare hands. Allow the oil to drain into a container.



⚠ DANGER

Hot oil and components can cause personal injury. Do not allow hot oil or components to come into contact with the skin.

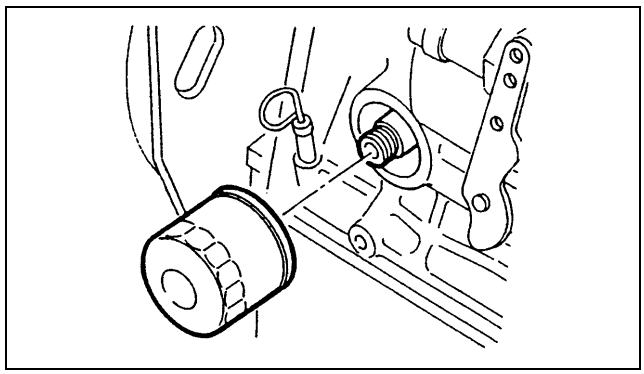
6.3.2 Changing the oil filter

1. Remove the used oil filter with a filter wrench.

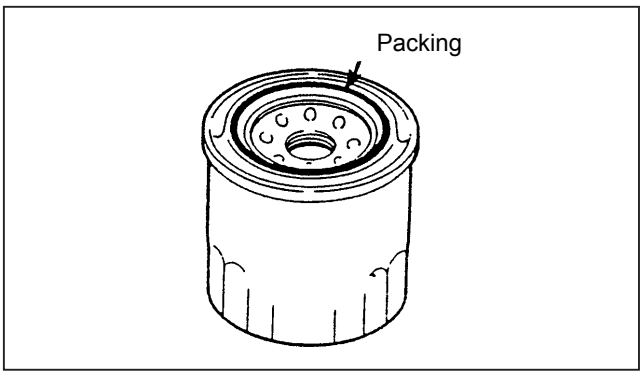
⚠ NOTE

Check particles collected in the used oil filter. If they are metallic particles, you should consult your Mitsubishi dealer.

2. Make sure that the formerly used packaging is removed from the filter base and clean the base with a clean cloth.



3. Check the new oil filter and make sure that the packing is fitted in the groove.
4. Apply a thin coat of engine oil to the packing of the new filter.
5. Install the new filter by hand until its packing touches the base. Tighten it by 3/4 to 1 turn.



6.3.3 Filling with oil

1. Install the drain plug and tighten it to the specified torque.

Torque
4.5 ± 0.5 kgf/m (33 ± 4 lbf/ft) [44 ± 5 N/m]

Table 5 Specified torque

2. Fill the crankcase with oil.

Refill capacity	See SPECIFICATIONS
API Service Classification	CF or CF-4

Table 6 Fill crankcase

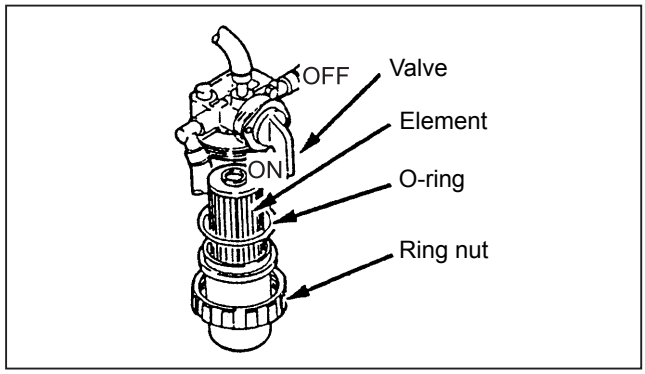
3. Start the engine, leave it idling for a few minutes, and check for leaks. Re-tighten the filter in case of leakage.
4. Stop the engine and leave it inert for about 30 minutes; then re-check the oil level. Maintain the oil level between the MAX and MIN marks on the dipstick. Add oil only if necessary.

6.4 Every 500 service hours

6.4.1 Change fuel filter element

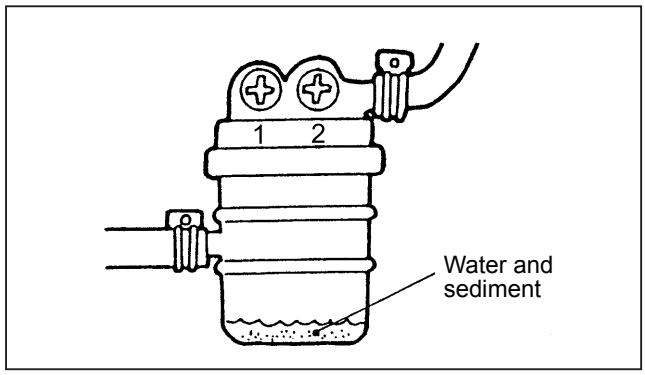
Fuel filter with cut off valve

1. Turn the valve to the OFF position.
2. Loosen the ring nut and remove the cup.
3. Remove and discard the filter element.
4. Put the new filter element in the cup and install the cup, making sure the O-ring is properly fitted into place. Tighten the ring nut.
5. Turn the valve to the ON position and prime the fuel system (see page 31 for priming).



Cartridge type fuel filter

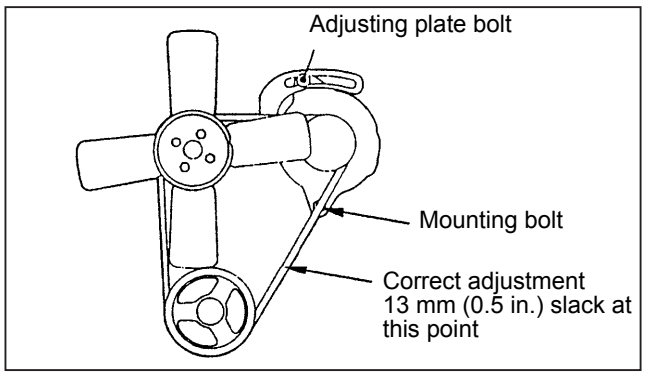
1. Change the filter if water and sediment have been collected in the filter.
2. After changing the filter, prime the fuel system (see page 31 for priming).



6.4.2 Check and adjust the fan belt

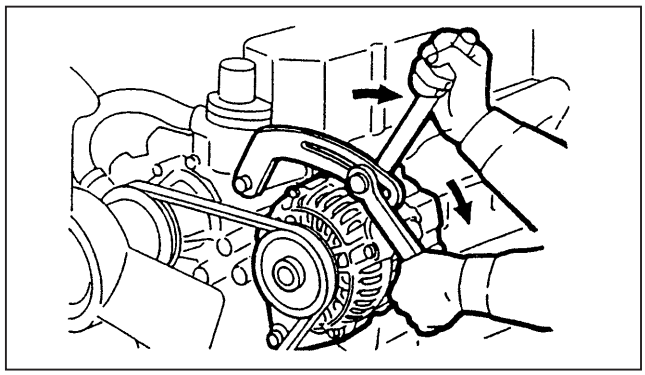
Checking

Correct adjustment exists when the belt can be pushed inward about 13 mm with 100 N thumb pressure exerted midway between the alternator and crankshaft pulley as shown.



Adjusting

1. Loosen the adjusting plate bolt and the mounting bolt.
2. Insert a bar between the alternator and the cylinder block to move the alternator to obtain the required belt deflection.
3. Tighten the mounting bolt and the adjusting bolt.



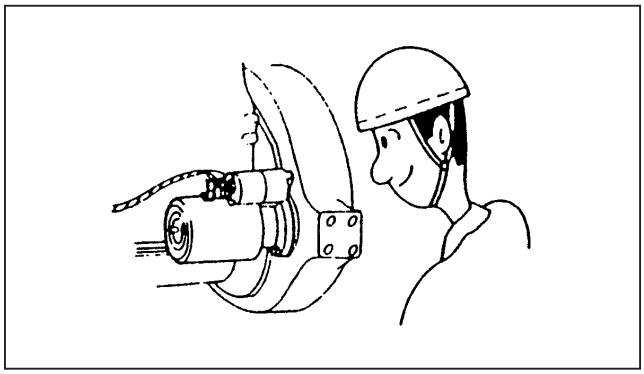
⚠ CAUTION

- If the fan belt is too tight, excessive stress is put on to the fan bearings and belt, which might shorten the life of both. If it is too loose, it will slap against the pulleys, causing unnecessary wear and tear to the belt, which could cause possible slipping, to the extent that the engine will overheat.
- Keep the belt free from oil or grease.

6.5 Every 1000 service hours

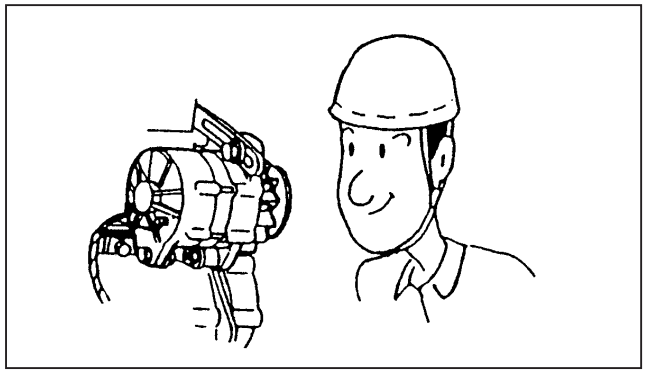
6.5.1 Check the starter

1. Check for visual defects.
2. Check to see if the pinion is shifted into mesh with the flywheel ring gear when the starter is energized. If the pinion does not shift properly, consult your Mitsubishi dealer.



6.5.2 Check the alternator

1. Check for visual defects.
2. Remove the belt from the alternator. Turn the pulley by hand to check the alternator for smooth rotation. If the alternator fails to rotate smoothly, consult your Mitsubishi dealer.



6.6 Every 2 years

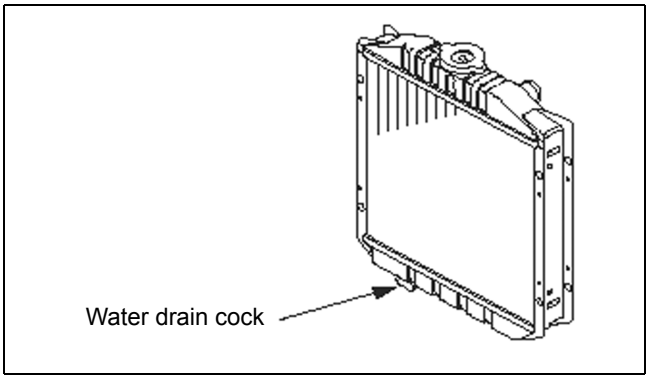
6.6.1 Change coolant

Long Life Coolant (LLC) used in your engine retains its efficiency for 2 years. Be sure to change the coolant every 2 years.

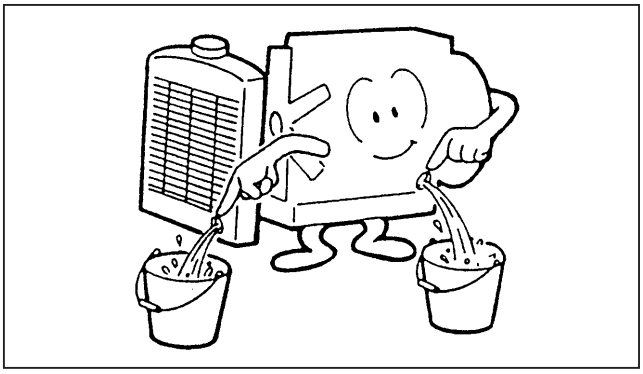
6.6.2 Draining

1. Start and operate the engine until the coolant temperature is 70°C to 80°C (158°F to 176°F). Then stop the engine.
2. Remove the filler cap only after the engine has been stopped and the cap is cool enough to remove with your bare hands.

3. Open the radiator drain valve and remove the engine drain plug.



4. Then allow the coolant to drain into the containers.

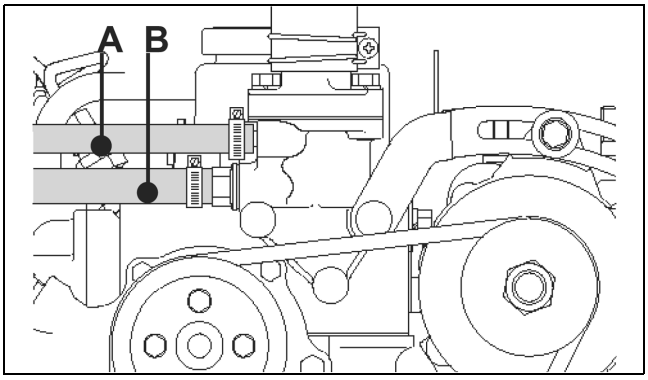


6.6.3 Flushing

1. Close the radiator drain valve and install the engine drain plug.
2. Fill the cooling system with a cleaning solution which does not chemically attack rubber or metal surfaces. Start and operate the engine at 800 to 900 rpm and let the engine run for 15 minutes. Stop the engine and drain the cleaning solution.
3. Fill the system with clean water and operate the engine at 800 to 900 rpm for 10 minutes. Continue to flush the system until the draining water is clear.

6.6.4 Refilling

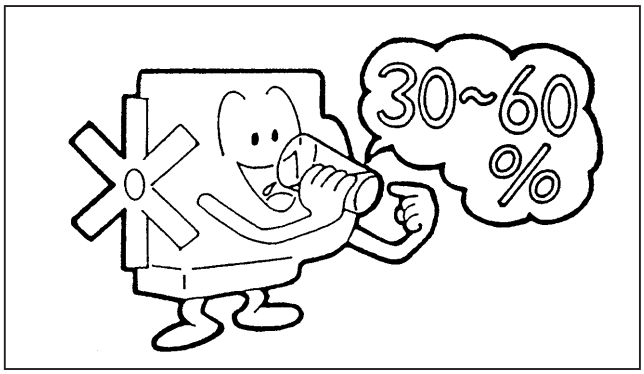
1. Tighten the radiator drain valve and the engine drain plug.
2. Remove the by-pass hose (A) at the thermostat housing.
3. Remove the cabin heater hose (B) at the thermostat housing (if installed).



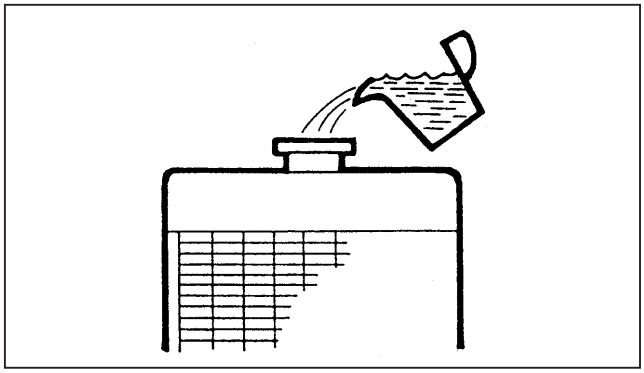
4. Pour pure, undiluted LLC into the radiator; see COOLANT AND ANTIFREEZE SPECIFICATIONS on page 36. The recommended concentration of LLC is illustrated in the chart below:

Ambient Temperature, °C (°F)	-10 (14)	-20 (-4)	-30 (-22)	-45 (-49)
LLC concentration, %	30	40	50	60

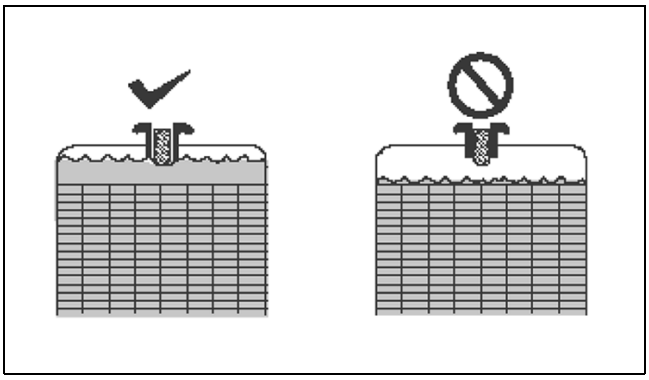
Table 7 Recommended LLC Concentrations (reference)



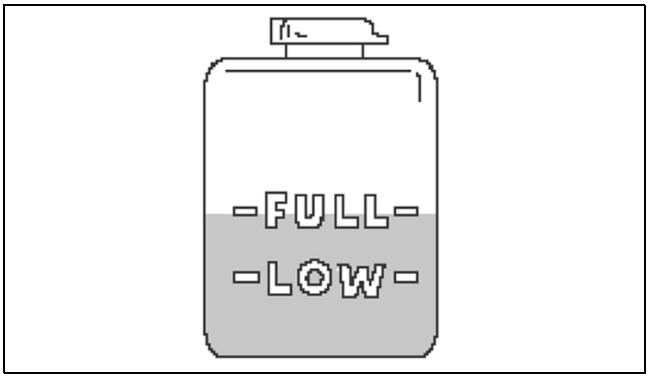
5. Fill the cooling system slowly with coolant through the radiator cap opening to avoid air being trapped in the system.



6. Re-install the by-pass and cabin heater hoses, if coolant reaches the top level and tighten the clamps.
7. Bleed the air at the cabin heater system.
8. Run the engine for a few minutes at low idle with the radiator cap open.
9. Stop the engine and check the coolant level; fill-up if necessary, re-install the radiator cap.



10. Start and operate the engine until the coolant temperature is between 70°C and 80°C (158°F to 176°F). Check for any leaks. Then stop the engine. Repair any leakage if necessary.
11. Check the coolant level in the reservoir tank and add water if the coolant level is low. Maintain the coolant level to FULL line on the tank when the engine is cold.



6.7 When required

6.7.1 Prime fuel system

Air in the lines may cause the fuel system to become air bound, resulting in an inability to start the engine or the misfiring of one or more cylinders. Prime the fuel system:

1. After the engine has been fueled for the first time after installation.
2. After the engine has been refueled after running out of fuel.
3. After the fuel filter element has been cleaned or replaced.

6.7.2 Procedure

Fuel filter with air valve

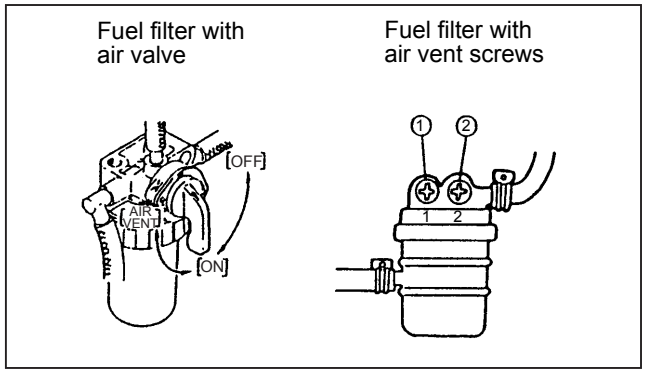
1. Turn the valve lever to the AIR position and feed the fuel.
2. If the fuel flows free of bubbles through the fuel return pipe, turn the valve lever to the ON position.

Fuel filter with air vent screws

1. Loosen the air vent screw (1). Tighten the screw when the fuel flows free of bubbles.
2. Loosen the air vent screw (2). Tighten the screw once the fuel flows free of bubbles.

⚠ NOTE

The injection pipes and nozzles can be primed by cranking the engine. The fuel system of the engine equipped with an electric fuel pump can be primed by turning the starter switch key to the ON position.

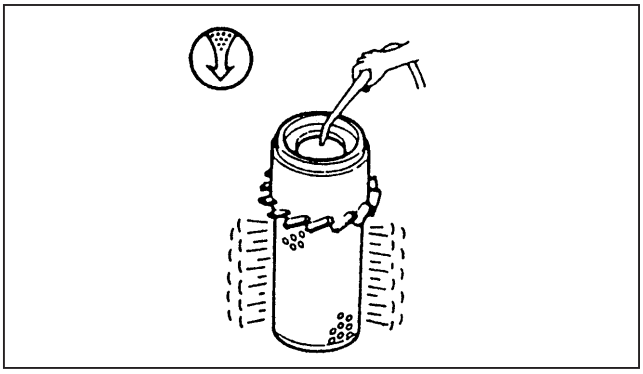


6.7.3 Clean/change air cleaner element

Service the air cleaner only when it is necessary, or when the dust indicator indicates RED.

6.7.4 Cleaning

1. Direct air — 7 kgf/cm^2 (100 psi) [686 kPa] maximum — inside the element along the length of pleats.
2. Insert a light inside the clean element and check. Replace the element if rips or tears are found.



⚠ NOTE

Replace the element if it is excessively dirty.

⚠ CAUTION

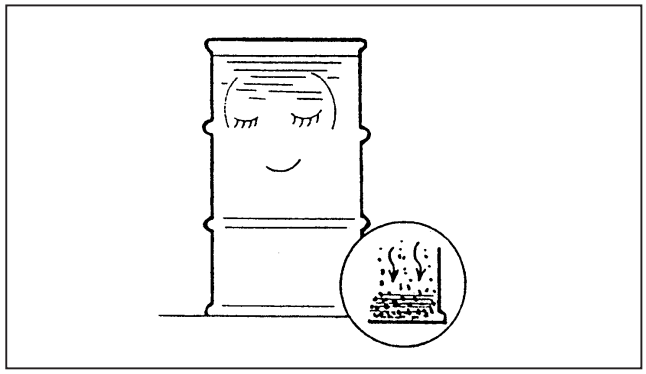
- Never service the air cleaner when the engine is running. Without the air cleaner, dust and dirt can enter the engine and can cause rapid wear of the engine parts resulting in loss of power and high oil consumption.
- Do not clean the element by bumping or tapping it.

⚠ WARNING

When using compressed air for cleaning, wear a protective face shield, protective clothing, and protective shoes.

7 FUEL SPECIFICATIONS

7.1 Recommended types of fuels

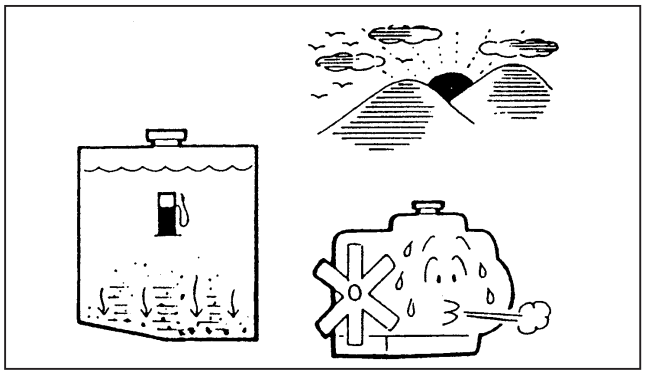


The quality of fuel is a very important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust emission levels.

This engine is designed to burn fuels marketed to meet ASTM Designation D 975 (grade No. 2-D).

7.2 Caring for the diesel fuel tank

Fill the diesel fuel tank at the end of the day, because the incoming fuel will drive out the moisture-laden air and prevent condensation. Before starting the engine after 50 service hours, remove the drain plug and drain off any sediment or water which may have accumulated.



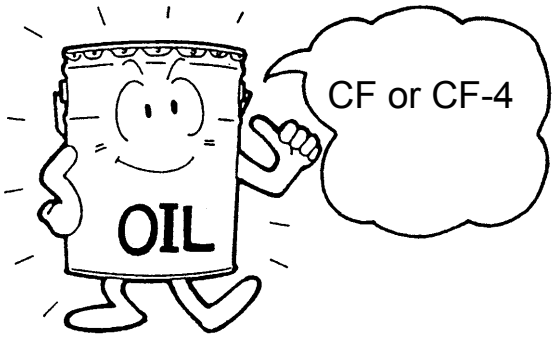
7.3 Caring for the fuel supply

It is important to buy clean fuel and keep it clean. Natural settling is an effective method of cleaning fuel. Allow the fuel to stand for at least 10 days in the fuel storage tank after the tank has been filled and before the fuel is transferred to the diesel fuel tank. Be sure to drain all the water and sediment that has settled in the bottom of the tank before the tank is refilled. Occasionally, drain all of the fuel and clean the tank thoroughly.

8 LUBRICANT SPECIFICATIONS

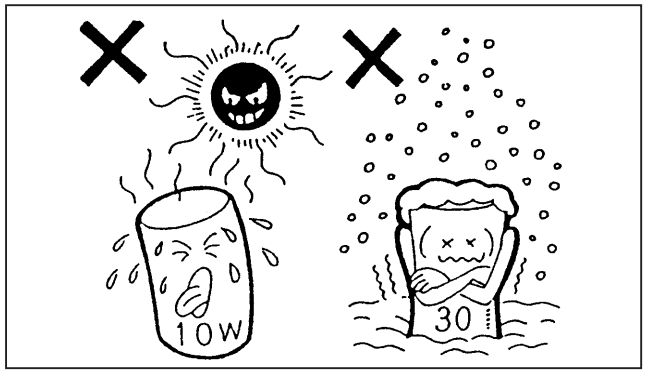
8.1 Recommended types of engine oils

Use oils that meet the API engine oil classification CF or CF-4 class. Proper oil selection assures cranking ability by maintaining an oil film on the cylinder walls and bearing surfaces in conditions which provide low friction and therefore less cranking effort to achieve cranking speeds necessary for reliable starting. Improper oil selection may result in congealed oil film on the cylinder walls and the bearing surfaces. This can result in high friction loads and more cranking effort, thus standing in the way of achieving sufficient cranking speeds for reliable starting and affecting engine life.



8.2 Recommended oil viscosities

There are two important considerations related to satisfactory engine operation under ambient temperature conditions — (1) the ability to crank the engine fast enough to assure starting, and (2) adequate lubrication of internal wearing surfaces during starting and warm-up. These considerations can be adequately met through proper grade selection. Recommended oil viscosities are shown in the chart below:



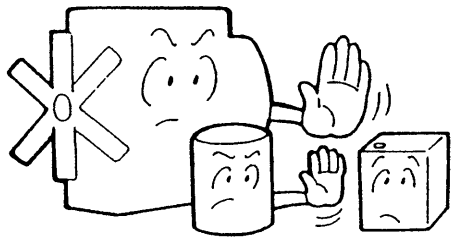
Starting temperature, °C (°F)	-30 (-22)	-25 (-13)	-20 (-4)	-15 (5)	-10 (14)	-5 (23)	0 (32)	10 (50)	20 (68)	30 (86)	40 (104)
Oil viscosities	SAE 5W-20										
	SAE 10W-30										
	SAE 15W-40										
	SAE 40										
	SAE 30										

Table 8 Recommended oil viscosities

Mitsubishi recommends the all-season type engine oil of SAE 10W-30.

⚠ CAUTION

Avoid mixing oils with different brands. In most cases, oils with different brands are not compatible and, when mixed, they can seize parts such as piston rings, cylinders, etc. and cause wear to moving parts. It is best to stick with the same brand and one type of oil at successive service intervals.



8.3 Limiting requirements for engine oils

If a used oil analysis program is conducted in order to determine the condition of the oil, consult the chart below. Change the oil if any of these requirements are not met.

⚠ NOTE

- Oil change intervals depends on the fuel properties. Be sure to use the recommended fuels only.
- The limit of total base number is 1/2 of that of a new oil in case of a perchloric-acid analysis method.

Property	Unit	Test Method	Limit
Viscosity	cSt @ 100°C (212°F)	JIS K 2283	+30% / -15% , max. of new oil
Total base number (HCl)	mgKOH/g	JIS K 2501	2.0, min.
Total acid number	mgKOH/g		+3.0, max. of new oil
Water content	Vol%	JIS K 2275	0.2, max.
Flash point	°C (°F)	JIS K 2265	180 (356), min.
Pentane insolubles	Wt%	ASTM D 893	0.5, max.
Pentane insolubles coagulated	Wt%		3.0, max.

Table 9 Limiting requirements for engine oils

9 COOLANT AND ANTIFREEZE SPECIFICATIONS

9.1 Coolant specifications

Water used in the engine cooling system must be soft, or as free from scale forming minerals as possible and it has to meet the requirements shown in the "Coolant Specifications" chart.

⚠ NOTE

Harmful chemical properties and substances contained in water (as coolant) must not exceed the Mitsubishi limits. They are tolerable up to the limits shown in the chart below.

Item	Chemical symbol	Unit	Recommended limit	Main malign effect	
				Corrosion and rust	Scale formation
pH, 25°C (77°F)	-	-	6.5 to 8.5 (6.5 to 8.0)	O	O
Electrical conductivity, 25°C (77°F)	-	μ Ω/cm	< 400 (< 250)	O	O
Total hardness	$CaCO_3$	PPM	< 100 (< 95)	-	O
M alkalinity	$CaCO_3$	PPM	< 150 (< 70)	-	O
Chlorine ion	Cl^-	PPM	< 100 (< 100)		-
Sulfuric acid ion	SO_4^{2-}	PPM	< 100 (< 50)	O	-
Total iron	Fe	PPM	< 1.0 (< 1.0)	-	O
Silica	SiO_2	PPM	< 50 (-)	-	O
Residue from evaporation	-	PPM	< 400 (< 250)	-	O

Table 10 Coolant specifications

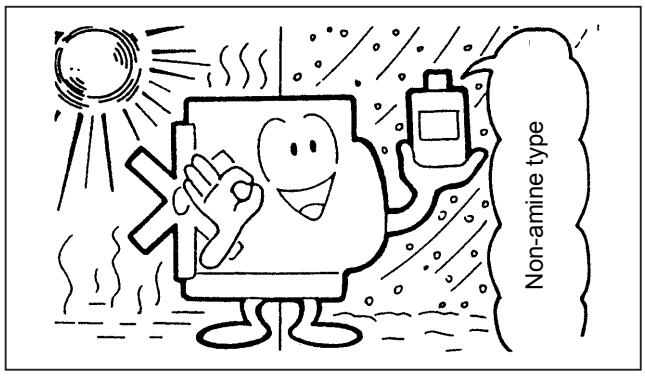
The values indicated in ( ) are the limits set forth by Mitsubishi. In addition to the items specified above, turbidity is specified to be <15 mg/l.

9.2 Recommended types of LLC's (Long Life Coolant)

For Mitsubishi diesel engines, all-season, non-amine type LLC's or equivalents are recommended.

9.2.1 Features of recommended brands

- No amines (methyl amines, ethyl amines, n-propyl amines, etc., all being derivatives of ammonia, NH_3) are contained.
- Silicate and borate are not contained.
- Close to neutral on the pH scale, and hence, slightly basic (alkaline).
- Balanced additive ingredients; some being substitutes for amines.
- Long life (the coolant with 30% concentration, for example, retains its effectiveness for more than 2 years).



⚠ WARNING

LLC is toxic and can cause personal injury if it comes into contact with the skin or the eyes. If LLC gets in your eyes, wash them with water immediately and see a doctor at once.

9.3 How to use non-amine type LLC

1. The engine coolant with any of the recommended additives should be changed every 2 years.

⚠ NOTE

When using any other LLC, refer to the coolant mixture chart shown on the container.

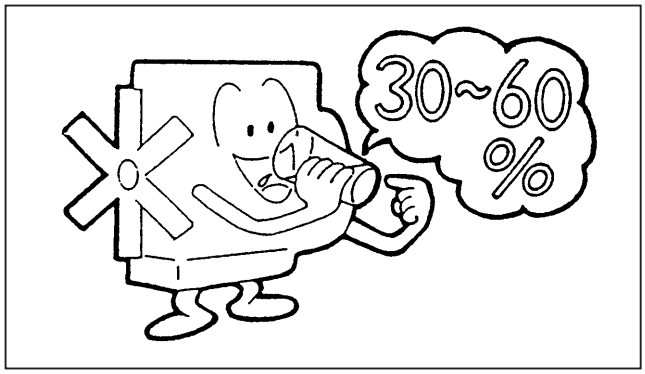
⚠ WARNING

Consult your Mitsubishi dealer for disposal of a used coolant containing LLC.

2. The proper concentration of LLC is from 30% to 60% all year round. Aim at a temperature level which is 5°C (9°F) lower than the expected lowest temperature. LLC of less than 30% concentration does not provide sufficient corrosion protection. Concentrations over 60% adversely affect freeze protection and heat transfer rates. When adding coolant, use LLC of the same concentration.

Ambient temperature, °C (°F)	-10 (14)	-20 (-4)	-30 (-22)	-45 (-49)
LLC concentration, %	30	40	50	60

Table 11 Recommended LLC concentrations (reference)



9.4 Why LLC?

Today's full-blown trend is toward smaller and more lightweight engines, higher output, lower fuel consumption, and lower exhaust emission levels. Engine application has also expanded. In most applications, the engine coolant is compelled to withstand severe conditions such as continuous high-power operation with a higher coolant temperature and a higher speed of coolant recirculation in the cooling circuit. Many materials involved in the circuit (such as steel, aluminum, copper, solder, and rubber) are also subject to severe servicing. These materials differ in ionizing tendency and this difference promotes cavitation and deterioration through the medium of engine coolant. The ideal of breaking the link between cause and effect to preserve the circuit can be realized by using LLC.

9.5 How LLC works

LLC contains several chemicals in such proportions as to produce a chemical reaction that suppresses corrosion of the engine parts in contact with coolant. "Corrosion" is the result of a phenomenon called "ionization."

The power of LLC to defeat the ionic reaction is generally subject to wear and the engine coolant becomes increasingly weak at that time.

Moreover, if its chemicals are not properly proportioned to match the circuit metals which

they are meant to protect, they are used up due to aging and this allows some metals to precipitate into the coolant or to form new compounds which can result in rusty surface deposits. Some chemicals, calculated to inhibit this ionic reaction, might accelerate the reaction of those metals that have already begun to react.

The worse case scenario is that the process of the ionic reaction or corrosion will go on faster than when the coolant is straight water without additives, if there is not a good match between the chemical proportions and the circuit metals.

9.6 Practical reported cases of circuit trouble for which additive is blamed

Case 1:

Amines are generally effective in suppressing the rusting of ferrous metals but are said to be problematic for copper and cupric metals because of copper involvement in pittings reported on Fe metals. The mechanism of Fe-surface pitting may be explained as that of galvanic or local-cell action. Suppose a cluster of copper molecules precipitates and deposits itself on a surface of Fe, a base metal relative to copper. The copper deposit introduces a localized galvanic cell which, by its ionic action, rapidly eats into the Fe surface to result in a pit.

Case 2:

A silicate (there are several types of silicate) is highly effective in protecting aluminium against rusting. This compound of silicon is unstable in a solution whose pH is 9 or less: it is prone to turn to gel and settle down in the solution. For this reason, the pH is usually specified to be 10 or so. This means that the silicate has to be used in a high-alkalinity coolant. When the silicate is used up, the high alkalinity starts chemically attacking the aluminium.

Example

The mechanical seal of the water pump may rapidly wear down as the secondary effect of silicate gel in the above context.

Case 3:

As the additive as a whole deteriorates or when its concentration in the coolant is too low, its anti-corrosion performance falls and consequently the circuit metals begin to corrode. Of those metals badly affected in such a condition, brass and solder — the materials used in the cores of the radiator — become particularly victimized. The cause of coolant leakage from and clogging of the coolant circuit in the radiator is usually traceable to such a malcondition of the coolant.

10 STORAGE

10.1 Storage of the engine in a non-operational condition

10.1.1 Preparation

1. Drain the engine oil and put a preservative into the engine (up to the high level on the dipstick).
2. Make a mixture of preservative and fuel oil in a 50-to-50 ratio and put the mixture into the fuel tank.
3. Start and leave the engine idling for 5 to 10 minutes.
4. Stop the engine and spray volatile preservative (VCI) into the opening of the air inlet.
5. Drain the preservative-fuel mixture.
6. Apply a coat of preservative to the exposed machined surfaces of the engine.
7. Cover the air inlet, the exhaust openings, and the breather by taping them.
8. Loosen the fan belt.
9. Tape the starter and the alternator terminals. Cover the starter and alternator with a polyethylene sheet and put a desiccant inside.
10. Disconnect the cables from the battery and charge the battery. Flush the top of the battery with clean water and coat the poles with acid-free vaseline to prevent further corrosion. Keep the battery in a cool, dry place.
11. Cover the engine to protect it against the weather.

⚠ NOTE

- Store the engine in a well-ventilated room.
- It is not necessary to drain the coolant if it contains LLC.
- Attach a "DO NOT OPERATE" sign or similar warning tag to the starter switch or any of the controls.
- New engine oil may be used instead of preservative.

10.1.2 Service during storage

Charge the battery at least once a month.

10.1.3 Remove the engine from storage

1. Remove the covers from the engine.
2. Connect a fully charged battery to the engine.
3. Remove the covers from the starter and the alternator.
4. Adjust the fan belt.
5. Remove the covering and the taping from the various ports.
6. Drain the preservative and fill the engine with the recommended engine oil.
7. Fill the fuel tank and prime the fuel system.
8. Check under and around the engine for items such as loose or missing bolts, oil, fuel, or coolant leaks.
9. Remove the rocker cover and lubricate the valve mechanism.
10. Crank the engine 3 times, 10 seconds each time, at intervals of 1 minute, with the fuel supply shut off.
11. Make sure the engine oil pressure rises properly.
12. Open the fuel supply valve and start the engine.
13. Allow the engine to leave it idling.
14. When the engine has run long enough to warm up, apply the load and bring it to an operating speed.

10.2 Storage of the engine in an operational condition

10.2.1 Follow steps 1 through 3 mentioned below once a month:

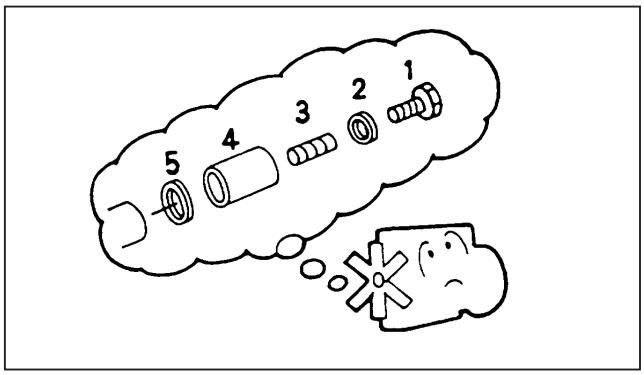
1. Crank the engine 2 times, for 10 seconds each time, with the starter at intervals of 30 seconds, with the fuel supply shut off. Open the fuel supply valve afterwards.
2. Start and operate the engine at 800 rpm under no-load condition for 5 minutes.
3. Increase the engine speed from 1000 to 1200 rpm and operate the engine under no-load condition for 10 minutes.

11 TROUBLESHOOTING

11.1 General

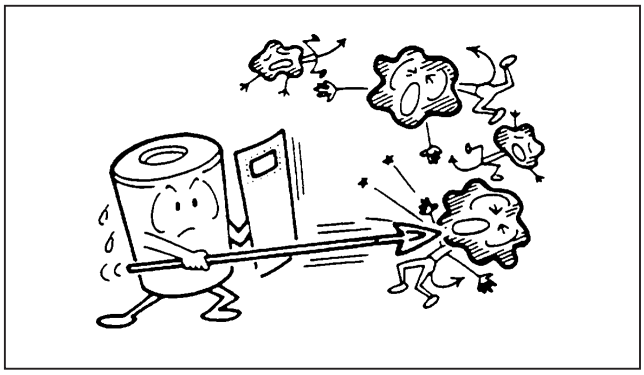
11.1.1 Think before you act

Upon noting a defective indication, recall what you did the last time when you came across the same indication. If what you did was correct and successful, do the same again. If the symptom noted is new to you, think of a possible cause in accordance with the troubleshooting procedure which follows.



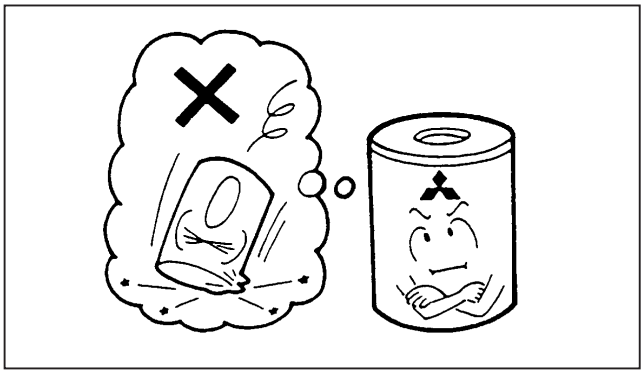
11.1.2 Dust and dirt are often the main causes

"Wear" is usually the result of abrasive particles. When disconnecting or disassembling a part or component, be sure to keep out dust and dirt.



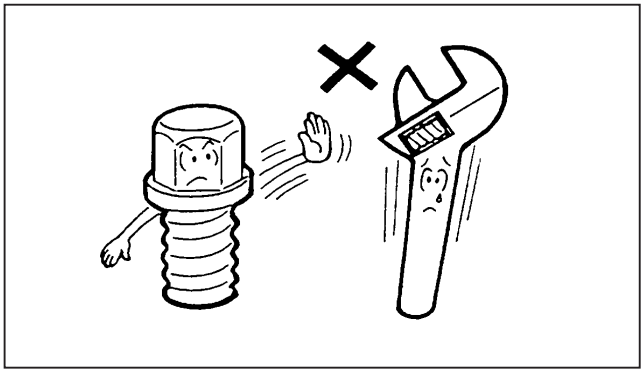
11.1.3 Use original parts

Use only original parts to replace those that have failed or reached their service limits. When ordering, specify the needed replacement parts by referring to the Parts Catalogue.



11.1.4 Perform servicing work safely

Use the right kind of hand tools to carry out each working step in repair work. Avoid injury to yourself and damage to the parts by using proper tools. When lifting or carrying a part that is too heavy for one person to handle, get another person's help and, if necessary, use a jack or a hoisting device.



⚠ CAUTION

- Never attempt to break the seals of the governor for maximum speed setting or maximum injection quantity setting.
- The maximum injection quantity of the injection pump has been set on the basis of the output power of each engine verified at the bench test. Never attempt to vary this injection quantity in the field.

11.2 Problems

For special servicing jobs on your engine, rely on the expert knowledge of the servicemen and the service facilities provided by your Mitsubishi dealer.

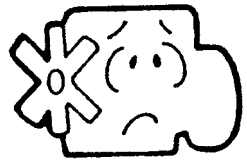
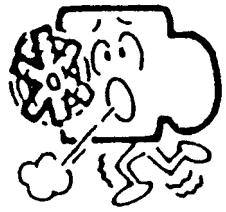
Problem	Cause	Correction
Engine will not start 	Fuse off	Replace
	Defective starter switch	Repair or replace*
	Slow cranking speed	Recharge battery
	Wrong viscosity grade of oil	Change correct oil
	Seized running parts	Repair*
	Air in fuel system	Prime
	No fuel in tank	Refuel
	Bad quality fuel	Change fuel
	Clogged fuel filter	Clean or replace
	Defective fuel injection pump	Repair or replace*
	Defective control timer unit	Replace*
	Clogged air cleaner	Clean or replace
	Defective starter or relay	Repair or replace*
	Open electrical circuit	Repair
Not enough power 	Wrong viscosity grade of oil	Change oil
	Clogged air cleaner	Clean or replace
	Clogged fuel filter	Clean or replace
	Defective fuel injection pump	Repair or replace*
	Defective fuel injection nozzles	Repair or replace*
	Wrong injection timing	Adjust*
	Bad quality fuel	Change correct fuel
	Overheating	Flush cooling system and replace parts
	Wrong valve clearance	Adjust
	Poor compression (cylinders, piston, rings, etc. worn)	Repair or replace*

Table 12 Troubleshooting

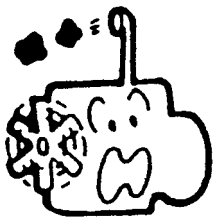
Problem	Cause	Correction
Overheating	Not enough coolant in system	Add coolant
	Leaks in cooling system	Retighten or repair
	Loose fan belt	Adjust
	Restriction to air flow through radiator	Remove restrictions
	Defective water pump	Replace
	Defective thermostat	Replace
	Defective fan	Replace
	High LLC concentration	Adjust LLC concentration
Too much white or blue smoke	Too much oil in engine	Drain to correct level
	Oil viscosity too low	Change oil
	Defective thermostat (coolant temperature too low)	Replace
	Defective fuel injection nozzles	Repair or replace*
	Wrong injection timing	Adjust*
	Wrong fuel cetane number	Change fuel
	Poor compression (cylinders, piston rings, etc. worn)	Repair or replace*
Too much black or gray smoke 	Bad quality fuel	Change fuel
	Defective fuel injection pump	Repair or replace*
	Defective fuel injection nozzles	Repair or replace*
	Wrong injection timing	Adjust*
	Clogged air cleaner	Clean or replace
	Wrong valve clearance	Adjust
	Poor compression (cylinders, piston rings, etc. worn)	Repair or replace*
Fuel consumption too high	Bad quality fuel	Change fuel
	Defective fuel injection pump	Repair or replace*
	Defective fuel injection nozzles	Repair or replace*
	Wrong injection timing	Adjust*
	Clogged air cleaner	Clean or replace
	Poor compression (cylinders, piston rings, etc. worn)	Repair or replace*

Table 12 Troubleshooting

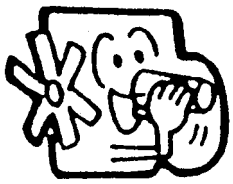
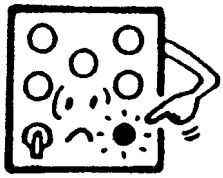
Problem	Cause	Correction
Oil consumption too high 	Too much oil in engine	Drain to correct level
	Oil viscosity too low	Change oil
	Leaks in lubrication system	Repair or replace
	Worn cylinders and piston rings	Repair or replace*
	Worn valve stem seals	Replace*
Oil pressure too low 	Not enough oil in engine	Add oil
	Oil viscosity too low	Change oil
	Clogged oil filter	Replace
	Defective oil pump	Repair or replace*
	Defective relief valve	Adjust or replace*
	Defective pressure switch	Replace*

Table 12 Troubleshooting

Remarks:

1. Consult your Mitsubishi dealer for items marked with an asterisk (*).
2. Consult your Mitsubishi dealer for any items other than those listed in the table.
3. When communicating with your Mitsubishi dealer, specify the engine model name, the engine serial number, the application, the rating, and service hour meter reading of your engine.

MITSUBISHI DIESEL ENGINES TURBOCHARGERS CORRUGATING MACHINERY

MEE MHI EQUIPMENT EUROPE B.V.

To whom it may concern

EC-declaration of incorporation
(Directive 98/37/EC, Annex II, sub B)
Ban on putting into service

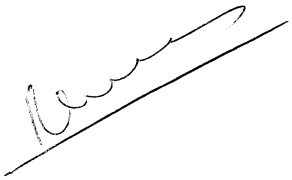
MHI Equipment Europe B.V.
Damsluisweg 2
1332 EC Almere
The Netherlands

herewith declares that:

the Mitsubishi diesel engine, SL-series type

is destined to be incorporated in other machines or to be combined with other machines, and is not (entirely) in compliance with the Machinery Directive (98/37/EC).

Almere, December 17th 2002



R.A.G.L. Manders
General Manager
Engine Division